



and



Technical Service Manual

For use with the following list numbers:

13038-04, Abbott AIM
13967-04, Abbott AIM Plus



ABBOTT LABORATORIES
NORTH CHICAGO, IL 60064
USA

430-600035-002 (Rev. 11/99)

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Part Number	Description of Change	Remove and Destroy Pages	Insert Change Pages
430-600035-001 (Rev. 12/96)	Original issue.	N/A	N/A
430-600035-002 (Rev. 10/99)	Second issue. Section 5: (1) Updated pump inspection checklist to match current service training. (2) Added alternate PVT procedures for performing the motor test, servo calibration, encoder test, and current supply test without a torque brake. Revised PVT Data Form to add alternate results. Section 6: Added procedure for setting February 29 on leap years. Section 7: Added alternate instructions for RTV sealing. General: Added Seiko DPU414 as compatible printer.	All	All

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Section 1

Introduction

1.1

Scope

This Technical Service Manual presents technical information about the Abbott Ambulatory Infusion Manager (AIM™) and Abbott Ambulatory Infusion Manager Plus (AIM® Plus) infusion pumps. It is intended for the trained technician experienced in analysis, troubleshooting and repair of analog and digital microprocessor-based equipment.

It is organized into the following nine sections:

- ☐ Section 1 Introduction
- ☐ Section 2 Warranty
- ☐ Section 3 System Operating Manual
- ☐ Section 4 Theory of Operation
- ☐ Section 5 Maintenance and Service Tests
- ☐ Section 6 Troubleshooting
- ☐ Section 7 Replaceable Parts and Repairs
- ☐ Section 8 Specifications
- ☐ Section 9 Drawings

Note: In this manual, the terms “pump” and “pumps” refer to all configurations of both the AIM and AIM Plus unless otherwise specified.

Note: Figures are rendered as graphic representations to approximate the actual product; therefore, figures may not exactly reflect the product. Display screens and touchswitch labels may vary slightly, depending on the configuration of the pump in use.

If a problem in the infusion system operation cannot be resolved using the information in this manual, contact Abbott Laboratories Technical Support Operations (*see Section 6.1, Technical Assistance*).

1.2

AIM and AIM Plus Overview

The pumps share the same design and functionality other than the hardware and software differences noted in *Section 1.2.2, AIM and AIM Plus Differences*.

1.2.1

Pump Description

The Abbott AIM and AIM Plus are single-channel infusion pumps designed to deliver fluids intravenously or epidurally. Special safety features integrated into the design include an over-pressure (occlusion) alarm, an air-in-line alarm, a back-up (safety) microprocessor, motor parameter monitoring, and numerous failure backup modes to prevent single point failures from endangering the patient.

The pump is powered by four 1.5V AA alkaline batteries, optional nickel metal hydride rechargeable battery packs, or an AC power supply. The pump is microprocessor-based and is programmed through a 24-key keypad on the front of the unit. The state of the pump is displayed using a 16-character by 4-line alphanumeric liquid crystal display (LCD) module. The unit requires dedicated cartridges to deliver fluids through rotary peristaltic pumping action. Control of the pump and of the cartridge assure accurate fluid delivery.

The pump detects occlusions and air in the fluid cartridge. If the pressure at the cartridge exceeds the specification occlusion alarm pressure, the instrument sounds an alarm and stops delivery. If air in the cartridge exceeds the pre-set sensitivity limit, the pump will alarm, stop delivering and not proceed until the air is cleared (the air sensitivity setting is variable, and for the AIM Plus can be deactivated, refer to the pump's System Operating Manual for more information).

The pump has several programming modes: TPN, Pain Management, Intermittent Delivery, Variable Time Delivery and Continuous Delivery.

The pump contains a time-of-day clock and history storing capability. Significant events that take place with the pump can be reviewed on the LCD display, along with time and date of occurrence. The pump contains a printer connector that also allows printout of this history information when the pump is connected to one of the two recommended compatible printers. Two different special printer cables (depending on printer choice) are available from Abbott as accessory items.

For specific instructions regarding pump operation, refer to the *AIM System Operating Manual* or the *AIM Plus System Operating Manual*.

1.2.2

AIM and AIM Plus Differences

The AIM and AIM Plus have the following significant hardware differences:

Table 1-1. AIM and AIM Plus Hardware Differences		
Item	AIM	AIM Plus
Beeper	Piezo element mounted on the bottom case; frequency approximately 4 KHz	Audio transducer mounted on the PCB; frequency approximately 2 KHz; protection diode added to beeper circuit (R135 replaced with 1SS353 diode) and resistor value changed in backup audio transducer oscillator circuit (R95 from 100K, 1% to 200K, 1%)
Function Keypad	Four raised profile switches with 4-15oz. actuation force	Three raised profile switches with 4-15oz. actuation force; STOP key has flat profile and 6-20oz. actuation force
Bottom Case	No molded recess; hole to emit beeper sound	Molded recess (0.020 inch) aids in installation of kapton insulator; no hole for beeper (AIM Plus beeper mounted on the PCB)

The AIM and AIM Plus have the following significant software differences:

Table 1-2. AIM and AIM Plus Software Differences	
Item	Significant AIM Plus Differences
Air Alarm Sensitivity	Air alarm can be turned completely off if air eliminating filter in use
Rate Change Lock	New feature added that allows programmable ranges for continuous and bolus rates to be locked in Pain Management programs
End of Infusion	END OF INFUSION alert added to TPN and Intermittent programs
Dose Frequency	Dose frequency increased from 24 to 96 hours in Intermittent programs
Interrupt Messages	Number of message screens displayed for a program interruption reduced in Intermittent and Variable programs
Program Review	Program review not required if pump is off less than 5 minutes; pump can be unlocked at power-on without program review
Change Mode	When changes are being made to a program, only those screens that can be altered are displayed
Lock Sequence Number	AIM is 13038, AIM Plus is 13967 (product list numbers)

1.3

Conventions

The following conventions are used throughout this manual:

- ❑ Touchswitches are described in all caps and enclosed in brackets, e.g., "Press [1], [0], [0] and [ENTER] to select a 100 mL container size."
- ❑ Screen displays referenced in the text are in all caps, e.g., "When resetting is complete two beeps sound and the INITIALIZE NVRAM OR USE ARROWS display returns."

Throughout this manual, warnings, cautions, and notes are used to emphasize important information as follows:

WARNING:

A warning contains special safety emphasis and must be observed at all times. Failure to observe a warning is potentially life threatening.

CAUTION: A caution contains information that could prevent irreversible equipment damage or failure.

Note: A note highlights information that helps explain a concept or a procedure.

Section 2

Warranty

Subject to the terms and conditions herein, Abbott Laboratories, herein referred to as Abbott, warrants that the product shall conform to Abbott's standard specifications and be free from defects in material and workmanship under normal use and service for a period of two years after purchase. Abbott makes no other warranties, express or implied, as to merchantability, fitness for a particular purpose, or any other matter.

Purchaser's exclusive remedy shall be, at Abbott's option, the repair or replacement of the product. In no event shall Abbott's liability arising out of any cause whatsoever (whether such cause be based in contract, negligence, strict liability, tort, or otherwise) exceed the price of such product, and in no event shall Abbott be liable for incidental, consequential, or special damages or losses or for lost business, revenue, or profits. Warranty product returned to Abbott must be properly packaged.

The foregoing warranty shall be void in the event the product has been misused, damaged, altered, or used other than in accordance with product manuals so as, in Abbott's judgment, to affect its stability or reliability, or in the event the serial or lot number has been altered, defaced, or removed.

The foregoing warranty shall also be void in the event any person, including the Purchaser, performs or attempts to perform any major repair or other service on the product without having been trained by an authorized representative of Abbott and using Abbott documentation and approved spare parts. For purposes of the preceding sentence, "major repair or other service" means any repair or service other than the replacement of accessory items such as batteries.

In providing any parts for repair or service of the product, Abbott shall have no responsibility or liability for the actions or inactions of the person performing such repair or service, regardless of whether such person has been trained to perform such repair or service. It is understood and acknowledged that any person other than an Abbott representative performing repair or service is not an authorized agent of Abbott.

Section 3

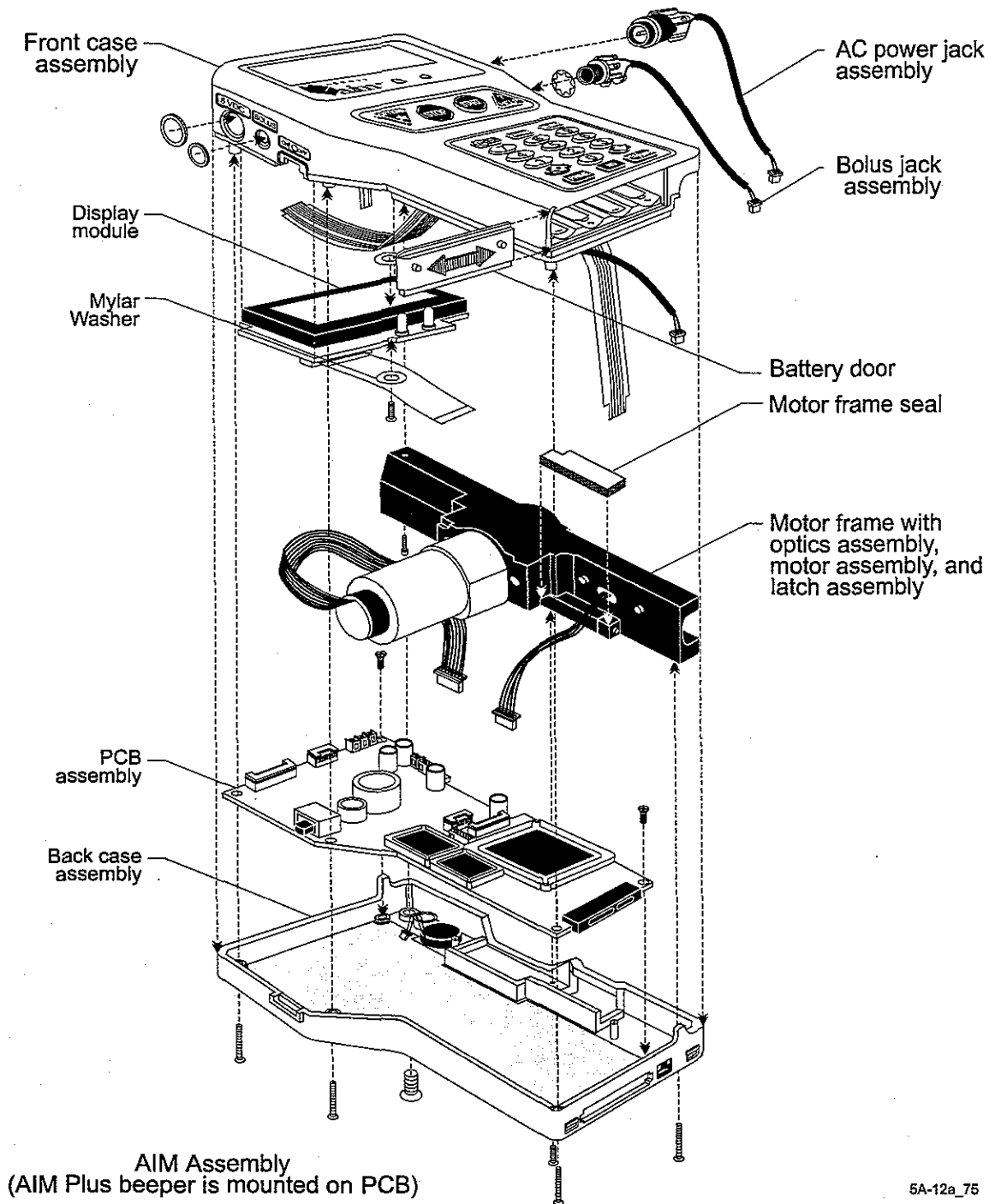
System Operating Manual

A System Operating Manual is included with every AIM and AIM Plus kit. Insert a copy in this binder's pockets for convenient reference. If a copy of the System Operating Manual is not available, contact Abbott Laboratories Technical Support Operations (*see Section 6.1, Technical Assistance*).

Section 4

Theory of Operation

This section describes the theory of operation of the AIM/AIM Plus. The pump has a modular construction as shown in *Figure 4-1. Assemblies*.



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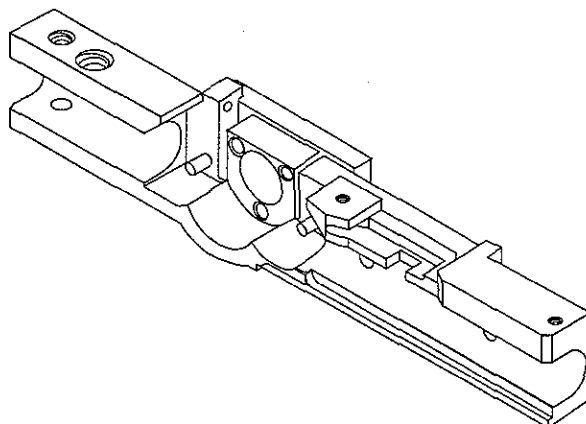
Figure 4-1. Assemblies

4.1

General Description

The pump case is constructed of durable, shock resistant plastic that contains or is coated with a conductive material to provide enhanced ESD and EMI protection for the pump electronics. The front half of the case houses the Liquid Crystal Display (LCD) and membrane contact keys. The motor frame is side mounted. Access to the electro-mechanical assembly of the pump is accomplished by the removal of retaining screws located on the rear case half. Battery compartment access is accomplished by removal of the battery door. Positive and negative terminals are constructed of spring clips. Positive and negative contacts are identified. The batteries are series connected and isolated from the optional power supply via diodes.

The motor frame aligns the cartridge to the drive motor and optical sensors, and completes the outer part of the pumping mechanism (refer to *Figure 4-2, Motor Frame*). Air-in-line and occlusion detection systems require correct cartridge alignment to function properly.



5D-19_25

Figure 4-2. Motor Frame

The location, height, and perpendicularity of the dowel pins determine the location of the cartridge within the motor frame. Dowel pin insertion into the motor frame is made by using specially designed equipment; for that reason, replacement of the motor frame must be performed by Abbott Laboratories.

The mechanical drive consists of a motor assembly (refer to *Figure 4-3. Motor Assembly*). The motor consists of a DC brush type, iron-less core motor with attached gearbox and integral Hall effect encoder built into the motor. The gearbox or transmission of the motor contains a 64/1 gear reduction to transform the relatively high speed, low torque output of the motor to the slower speed, higher torque requirements necessary to drive the rotary peristaltic cartridge pumping mechanism. The drive motor can be driven at various speeds, depending on the rate programmed.

The motor assembly includes an encoder, or tachometer. The encoder consists of a magnetic disc mounted on the motor shaft on the end of the motor opposite the gearbox. The disc contains multiple magnetic pole pairs. The encoder contains two Hall effect magnetic sensors, in quadrature, that create 16 pulses for every one motor shaft turn. The motor encoder outputs these 16 pulses, 90° out of pulse, on both phase 1 and phase 2 outputs. For each 64 by 16 tach pulses or 64 motor turns, the gearbox output shaft going to the cartridge completes one full turn, resulting in a fluid delivery of approximately 0.0876 mL. The pump's software keeps track of volume of fluid delivered by counting encoder pulses.

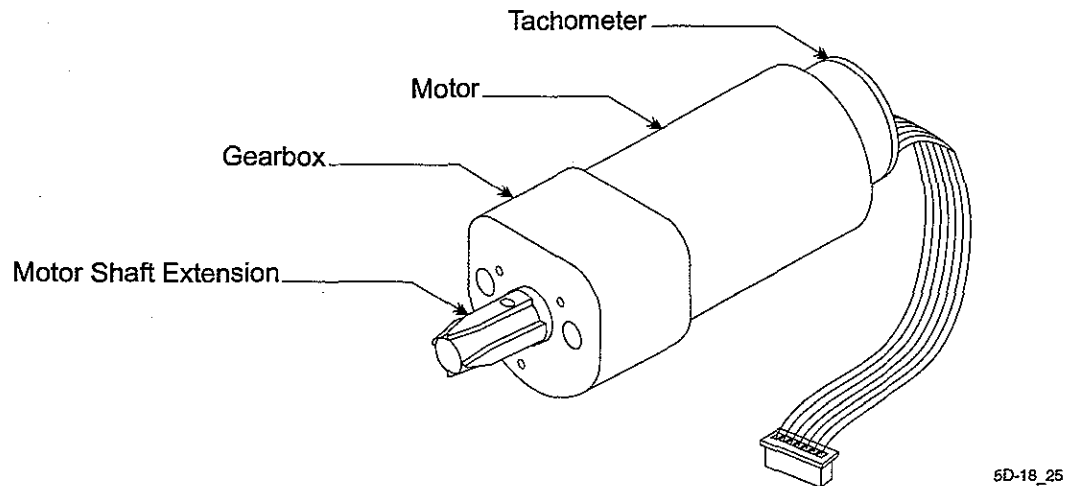


Figure 4-3. Motor Assembly

The motor/transmission assembly attaches to the motor frame with three locking screws. The motor shaft extension is molded with splines which mesh with the rotor in the cartridge set.

Air and occlusion detection is accomplished optically by reflecting infrared light beams off a sensing chamber within the cartridge. One LED/phototransistor pair forms the occlusion detector and another pair forms the air detector (refer to *Figure 4-4. Optics Assembly Detail*). Both pairs of detectors are mounted in an optics carrier assembly within the motor frame. When the cartridge is inserted correctly into the motor frame and latched, the sensing chamber area in the cartridge lines up correctly with the detectors in the optics carrier. In order to function correctly, all four optics surfaces must be kept clean and free of scratches which could impede light transmission.

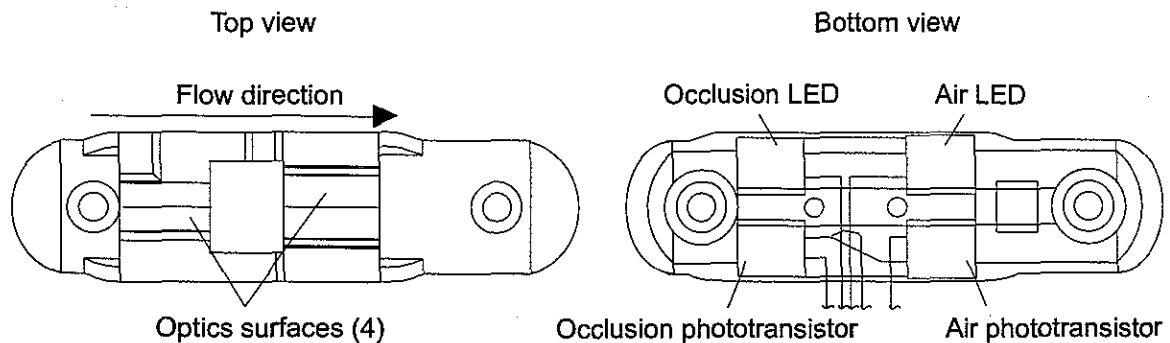


Figure 4-4. Optics Assembly Detail

When fluid is present in the cartridge, the air detect phototransistor receives relatively low levels of light because the fluid refracts most of the light from the phototransistor into the fluid rather than being reflected back to the phototransistor. When air is present in the sensing chamber of the cartridge the sensing chamber behaves as a mirror, reflecting much of the light from the LED back to the phototransistor. Presence of air thus causes the air detect phototransistor to go further into conduction (towards the on state). In summary, an air alarm means that the air detect phototransistor is on.

When no occlusion condition is present, light is returned to the occlusion phototransistor and the phototransistor is driven further into conduction. When a distal occlusion condition is present, the cartridge when turning causes a pressure buildup of the fluid inside the cartridge. This pressure buildup causes a small balloon segment within the cartridge sensing chamber to expand. When the balloon expands sufficiently such that a significant amount of the balloon surface touches the plastic on the inside of the sensing chamber, the balloon filled with fluid causes the mirror surface to become less reflective. An occlusion condition therefore results in a decrease in occlusion phototransistor drive and causes the transistor to go further out of conduction (towards the off state). When no cartridge is installed in the pump, or the cartridge is incorrectly installed no light will be reflected to the phototransistor and an occlusion alarm or check cartridge alarm will occur. In summary, an occlusion alarm means that the occlusion phototransistor is off.

The check cartridge alarm utilizes the same phototransistor sensor as the occlusion alarm. A check cartridge alarm is displayed whenever the lightpath is interrupted and the pump is not in the run state. Once the pump is running, the occlusion alarm will be displayed for any interruption of the light beam.

The latch holds the cartridge in the motor frame with tabs at two points to keep it properly aligned to the motor and the optics assembly (refer to *Figure 4-5. Latch Assembly*). One capture point on the cartridge is the indentation on the side of the cartridge near the rotor; the second point is a protruding tab on the cartridge next to the blue foil.

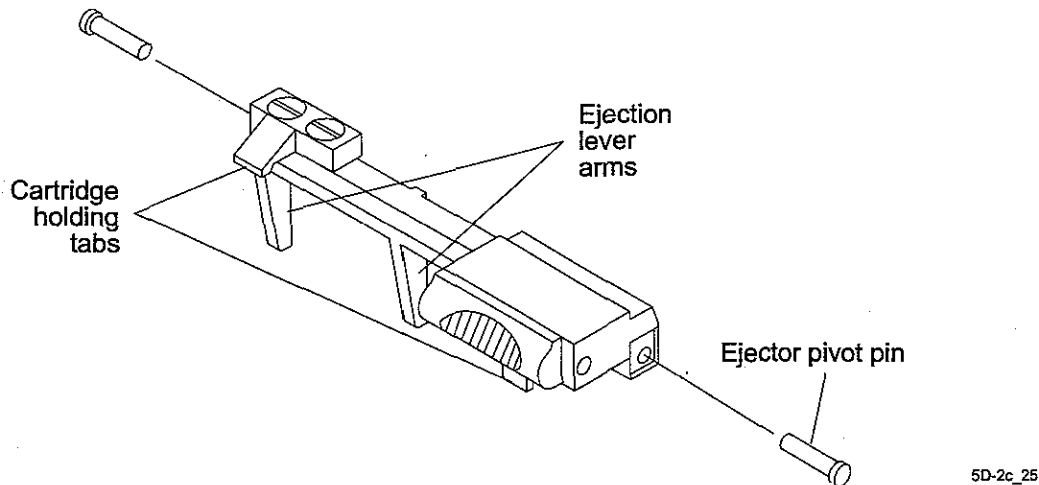


Figure 4-5. Latch Assembly

Two pivot pins hold the latch assembly onto the motor frame. Once the pump is assembled, tabs on the case hold the pivot pins in place.

The latch is opened by moving the thumb tab down and then rotating it back. This action rotates the lever arms outward from the motor frame and ejects a cartridge if one is installed. The latch is closed and the cartridge locked into place by moving the thumb tab down, inward and then upward.

4.2

Circuit Block Diagram

The heart of the Abbott AIM/AIM Plus circuit is the main microprocessor, a Motorola MC68L11K1FN (refer to *Figure 4-6. Circuit Block Diagram*). The MC68L11K1FN has nonmultiplexed address and data ports. It also has self-contained paging logic to allow the microprocessor to address up to 0.5 M byte of external memory. The self-contained paging logic plus internal chip select logic, allow a reduction in extra hardware required for the system. Since the paging and chip select logic is under software control, more flexibility is permitted in the system memory map and system operation. The microprocessor also contains four pulse width modulator outputs, which can be implemented as simple D to A converters, with a minimal amount of additional circuitry.

Peripherals to the main microprocessor are connected to the system via a common address and data bus. Each peripheral device has a unique range of addresses. The peripherals are the 16 character by 4 line display module, the real time clock, the 256K byte EPROM and 32K byte RAM. A small amount of additional address decoding logic is required for addressing the display and real-time clock, which are both chip selected by the main microprocessor's I/O chip select. When the main source of power is lost, power is supplied to the real-time clock and RAM via an internal backup lithium battery and automatic battery switch over circuitry. The clock will therefore keep running and the RAM information will be maintained even when power is lost.

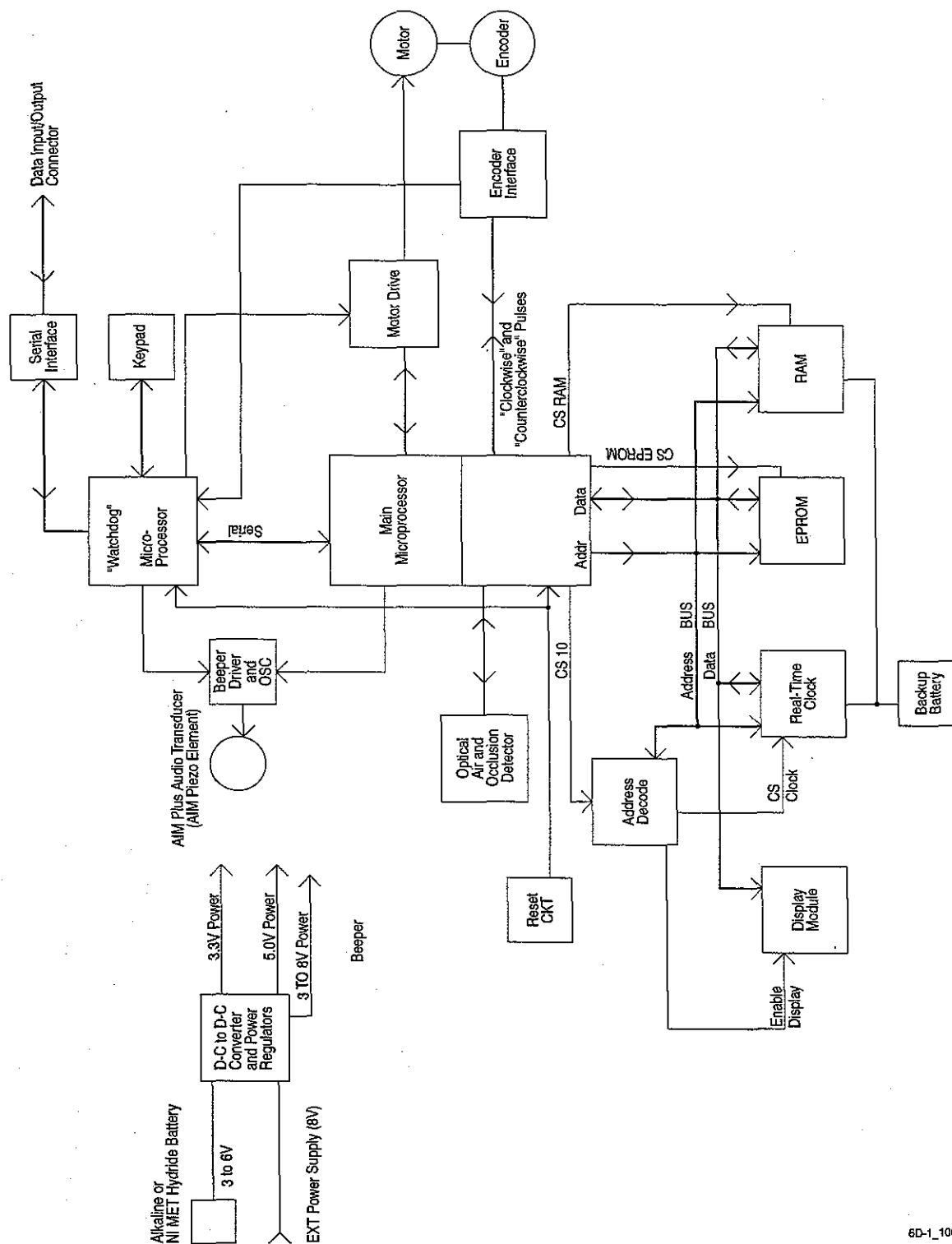
A watchdog or second microprocessor communicates to the main microprocessor via the serial SPI bus between the two microprocessors. The main function of the second microprocessor is to provide a second means of shutting off the motor or actuating the alarm. The watchdog microprocessor interfaces to the keypad and other devices via port lines.

The motor drive circuit regulates motor speed by maintaining a constant back EMF across the motor. The drive circuit has the capability of either stepping up or stepping down the supply voltage to drive the motor. At low motor speeds, the applied motor voltage may be less than the battery voltage and will be greater than the battery voltage at high motor speeds or flow rates. DC to DC converter technology is utilized to minimize circuit losses in the motor driver circuit.

The motor speed is monitored with a magnetic Hall effect encoder integral to the motor. The encoder delivers two phase quadrature pulses to the encoder interface circuit, which translates these pulses to clockwise or counterclockwise pulse information depending on the direction of rotation. Since the motor speed encoder is actually at the motor and not at the gearbox output shaft, the motor can actually turn in reverse or counterclockwise a small number of turns. By keeping track of the number of counterclockwise turns, the software can compensate for extra counts in the forward or clockwise direction due to shaft "windup."

Outputs from the optical air and occlusion detectors are read by the A/D converter in the main microprocessor. The A/D converter in the main microprocessor also monitors vital pump parameters such as battery and external power supply voltages, and motor voltages and currents.

There is a DC to DC converter that steps up the battery voltage to approximately 6V for driving the optics and beeper. The 6V in turn is converted via linear regulators to 5.0V and 3.3V for operation of the digital and analog circuits. Wherever possible, the digital circuitry is operated at a 3.3V supply voltage to minimize power consumption. There are a number of interface circuits required to interface between 5.0V supplied components (such as the display module) and 3.3V supplied components (such as the microprocessor).



6D-1_100

Figure 4-6. Circuit Block Diagram

4.3

Detailed Circuit Description

Refer to *Section 9, Drawings*, for the following fold-out schematics and PCB drawings:

- ☐ Figure 9-1, AIM Analog Schematic
- ☐ Figure 9-2, AIM Microprocessor (CPU) Schematic
- ☐ Figure 9-3, AIM Power and Miscellaneous Circuitry Schematic
- ☐ Figure 9-4, AIM PC Board, Front Side
- ☐ Figure 9-5, AIM PC Board, Back Side
- ☐ Figure 9-6, AIM Plus Analog Schematic
- ☐ Figure 9-7, AIM Plus Microprocessor (CPU) Schematic
- ☐ Figure 9-8, AIM Plus Power and Miscellaneous Circuitry Schematic
- ☐ Figure 9-9, AIM Plus PC Board, Front Side
- ☐ Figure 9-10, AIM Plus PC Board, Back Side

4.3.1

CPU System

4.3.1.1

Microprocessor (CPU)

The Motorola MC68L11K1FN microprocessor U19 forms the basis of the main CPU system. It and attached peripherals are supplied by a 3.3V VDD supply to achieve minimal power consumption. The 68L11 microprocessor contains an internal single inverter (parallel resonant) oscillator circuit utilized in conjunction with the 2MHz crystal, Y1. R37 biases the inverter for operation in a linear range and C17 and C16 provide the correct loading and phase shift to maintain stable oscillator operation.

Resistors R116 and R117 pull up the MODA and MODB inputs to VDD to program the microprocessor into the expanded memory mode of operation coming out of reset. R115 and C43 form a low-pass filter to supply a low noise reference to the internal A/D converter via VRH input to the microprocessor. The microprocessor has separate address and data lines. In addition, the microprocessor has internal paging logic controlled by extended address lines XA13 through XA18 that allow the microprocessor to access memory beyond its normal 64K limitation (controlled by A0 through A15).

The microprocessor also contains internal chip selects (CSPROG, CSGP2, CSGP1 and CSI0) that can be set up via software to issue chip selects for certain address ranges. The E-clock on the microprocessor is typically the crystal frequency divided by 4, or 500KHz in the case of a 2MHz crystal. The E-clock, however, can be stretched under software control to allow for slower peripherals.

4.3.1.2**EPROM**

The main program memory resides in the 27LV020 EPROM U15, which contains 256K bytes of memory space. The EPROM is addressed via the address lines A0 through A12. When jumper 12 is used, A13 is also addressed. If jumper 11 is used, XA13 through XA17 are addressed instead. This jumper option allows two different choices of window and bank sizes. Normal operation will call for the jumper JP12 and not JP11, giving a 16K wide window and 16 banks of EPROM memory. When the CPU first comes out of reset, the CSProg will be pulsing low, causing $\overline{CE}$ and $\overline{OE}$ on the EPROM to pulse low, thus chip selecting the EPROM. In addition the extended address lines will all be forced to the high state, causing program instructions to start executing from the highest page (15 DEC or 31 DEC, depending on the jumper option).

4.3.1.3**Microprocessor Supervisory Circuit**

The reset to both microprocessors is controlled by the microprocessor supervisory circuit, U21. This circuit issues a minimum 50 ms reset pulse whenever the VDD voltage is less than the battery BT2 voltage, or whenever PFI is less than approximately 1.3V. A reset will also be issued unless the watchdog internal to U21 is pulsed at least every 1.6 seconds via the WDI input from the microprocessor. The watchdog forces a reset in the rare event that the microprocessor crystal oscillator should fail, since both microprocessors run off the same crystal oscillator in U19. During reset, both microprocessors will force a motor off condition, and an alarm condition from the 6805 microprocessor, U18. U21 also controls the power source for the RAM U14 and time of day clock U20. Whenever VDD drops below BT2 battery voltage, the VOUT switches power from the VDD source to BT2 source. The final function of U21 is to provide a power loss warning to the CPU via the $\overline{XIRQ}$ input to U19. Whenever PFI falls below approximately 1.3V, the $\overline{PFO}$ output from U21 will go low, causing an interrupt to the microprocessor. R51 and R52 provide a voltage divider adjusted to cause the $\overline{XIRQ}$ whenever V_PWR is below approximately 3V. C23 acts as a filter to prevent noise pulses on V_PWR from prematurely triggering the $\overline{XIRQ}$ circuit.

4.3.1.4**RAM**

The RAM U14 contains 32K bytes of memory which is nonvolatile because its power supply is backed up by the lithium battery via the supervisory circuit U21. The RAM is addressed via address lines A0 through A14, allowing a RAM address range of 00000-07FFF. The chip enable to the RAM is provided by the microprocessor's CS GP2 via U2D and U12A. U2D inverts the active low CS GP2 line. The output of U2D is gated with $\overline{RESET}$ to prevent the RAM from being inadvertently written to during low power conditions. The chip enable to the RAM will thus be disabled whenever a reset condition exists. The $\overline{WE}$ to the RAM will be enabled whenever RD from the microprocessor is low (write condition). The $\overline{OE}$ is enabled when E-clock is high and RD is high (read condition). The eight data I/O lines to the RAM are interfaced directly to the microprocessor's 8 bit data bus D0 through D7. All address and data lines connected to the RAM are pulled low with pull down resistors in order to maintain all inputs in a known logic state when VDD power is lost, thus preventing floating inputs from raising the RAM's VCC supply current during lithium battery backup conditions.

4.3.1.5**Time Of Day Clock**

U20 contains a separate 32.768 KHz crystal oscillator circuit for low power consumption during battery backup conditions. C20 and C21 provide the necessary additional phase shift to maintain reliable oscillator function. The VDD supply for U20 is the same battery backed VDD supply utilized by the RAM. For the timer, it is also important that all inputs be pulled to a known logic state during power loss conditions, otherwise lithium battery current drains will be high. The $\overline{CS}$ to U20 is enabled by a combination of the microprocessor CSIO line and additional address decoding provided by U16. When A5-A11 are low and CSIO is low, U20 is chip selected, provided a reset condition does not exist. CSIO can be set active in the range of 1000-1FFF via software. The effective address for U20 then becomes 1000-101F. The NAND gate U12B allows reset to disable the chip select to U20, so that U20 cannot be written during low power conditions. U12C and U12D NAND gates allow ANDing of the E-clock with RD and $\overline{RD}$ signals to U20 in the proper time sequence. Note that U12 is also powered by the same battery backed supply as the RAM and time of day clock, thus insuring valid logic level "1" conditions to the control inputs of these devices and preventing inadvertent access or high backup battery current during power loss conditions.

4.3.1.6**Display**

The display is a separate self-contained module that is interfaced to the main board via U32. U32 buffers the data lines D4-D7, A0, and EN_DISP (U17-13) and provides a logic level translation from the nominal 3.3V bus system to the 5.0V bus levels required by the display for proper operation. The display is enabled via U17 when CSIO is low, A5 is high and A6 through A11 are low, giving an effective address of 1020-1021 for the display. The backlight to the display is enabled by driving Q6 on. U9A serves as a 3.3V to 5.0V translator to drive the gate of Q6 at a full 5.0V to insure low on resistance. The two LED's that are part of the display module are driven in a similar manner by U9D, Q12, U10A, and Q13. U2A, U9B, U11B, Q3 and associated components work to control the contrast of the display. The PW4 output is a pulse train output with variable duty cycle, controllable by software. This pulse train is applied to a low pass filter and divider R27, R28 and C13 which function to average the pulses into a dc level that is directly proportional to the duty cycle of the waveform. U11B and Q3 act together to function as a unity gain buffer, driving the contrast terminal (V0) of the display. The maximum display contrast is achieved when the drain of Q3 is at ground. Raising the level of Q3 will reduce the contrast to the display. C56 functions as a filter to smooth out pulses from the display and prevent oscillations.

4.3.1.7**Encoder Interface Circuit**

The encoder integral to the AIM Plus motor contains a Hall effect encoder with quadrature outputs, phase1 and phase2. These outputs are approximately 90 degrees out of phase with each other. By decoding the pattern of the two outputs, it is possible to determine if the motor is turning clockwise or counterclockwise.

PW2 generates a normally high, low going pulse that generates a strobe pulse to the encoder via buffer and level translator U10B and simultaneously clocks U7A and U7B. The encoder is strobed when PW2 goes low, and the state of both phases is latched into U7A and U7B when PW2 pulse goes high. Strobing the encoder helps reduce power consumption from the encoder, since the encoder is in a lower power state when its strobe input is low.

U8A and U8B detect that the encoder is turning in a clockwise (normal) direction and issue pulses on the CLKWISE line at the rate of the encoder pulses. Clockwise rotation is decoded when phase1 pulse rises followed by phase2 pulse rising. Counterclockwise rotation is detected by U31A and U31B whenever phase2 pulse rises followed by phase1 pulse rising. Pulses will appear on the CTRCLKWISE line at the encoder pulse rate whenever the motor turns counterclockwise or reverse direction. Normally the motor does turn clockwise except for very small amounts of counterclockwise rotation, usually as the motor is stopping due to "backlash" effects in the motor gearbox. By subtracting the small number of counterclockwise counts from the clockwise counts, the software can make corrections for the motor "backlash" and help improve flowrate accuracy at low flow rates.

4.3.1.8

Backup Microprocessor

U18 functions as a backup system or CPU watchdog to help prevent the pump from delivering fluid under fault conditions. U18 communicates to the main microprocessor U19 via the serial SPI bus, where PD4 is the clock line, PD2 is the serial data output from U18 and PD3 is the serial data input to U18. The oscillator input to U18 originates from the main microprocessor U19 via its XOUT pin. The TCAP input to U18 independently monitors the tach frequency from phase1 of the encoder. This frequency can be compared with software to the "clockwise" pulse from the encoder interface circuitry to detect most encoder or circuit failures. Most of the port lines are utilized to interface with peripherals such as the keypad and serial RS232 interface circuit. Most importantly, the motor can be disabled via PAX4, and the alarm can be enabled via PAX0, totally independently of the main microprocessor. Note that the X is used in the port line bus names to signify the association with the backup microprocessor.

4.3.1.9

Keypad Interface

The keypad is interfaced to the backup microprocessor U18 via ports PCX0-6 and ports PBX0-3. PBX0 through BPX3 are the pulsed column drives for columns 0 through 3, respectively, and the rows 0 through 6 are monitored for presence of pulses on input port lines PCX0 through PCX6, respectively. Resistors R5-R9, R11 and R16 are pull down resistors to maintain all row lines at a low level when no key is being pressed. Diodes D5-8 provide isolation on the row drivers to prevent keypad bus conflicts in the event that two keys in the same row are pressed simultaneously.

4.3.1.10

Bolus Switch Interface

The case mounted bolus membrane switch connect to the PC board via J15 and the remote bolus jack via J1. Both the external jack and the membrane switch are connected in parallel. If either switch is depressed, U2-13 is pulled to a low level and U2-12 issues a high level to PBX4. R3, R17 and C3 function as a low pass filter to prevent noise picked up from the remote bolus switch and cord assembly from falsely triggering a remote bolus request.

4.3.1.11**Serial Interface**

Connections to the external RS232 interface adapter cable are made via J8. J8 outputs a data and control line out and inputs a data in and control line in. It also provides 5.0V power and a control line to turn the RS232 interface on and off. The input and output lines are all filtered by resistor/diode networks for ESD protection. The diodes D21-D30 clamp the lines to either 5.0V or ground and resistors R82-91 are current limiting resistors to limit the current to the diodes and the inputs and outputs of U30. U30 acts as a buffer plus voltage level translator to translate from the 5.0V levels from the RS232 adapter to the 3.3V CPU system. R78, R80, D35 and D36 serve to limit the output current and voltage from U30D and E to properly interface to the 3.3V CPU ports.

4.3.2**Analog Circuits****4.3.2.1****Power Circuits**

The unit is powered by 4 AA cells connected via J6 or by an 8V power supply connected to J13. The two power sources are isolated via D3 and D11, so that whichever supply voltage is higher will actually be powering the pump. Normally, when the 8V power supply is plugged into the pump, it will override the 4 AA cells. Q1 and Q2 function together to turn on the load R30 and R33 whenever the TEST_BAT signal from the 6805 microprocessor is high. The load is turned on when a battery check is desired and the voltage is read via A to D input PE4 and filtered by C14. By placing a load (R30 and R33) on the battery when the battery voltage test is desired, a more meaningful measure of the battery condition can be obtained. Since the reference to the microprocessor's A/D converter is 3.3V, a battery voltage of 6.6V will cause a full scale reading (FF) at the A/D, because of the 2/1 divider R30, R33.

A/D input PE6 monitors the voltage of the 8V supply as provided by voltage divider and filter R32, R12 and C11. This input should read full scale (FF) for a 9.9V supply voltage. Divider R21, R22 and C12 supply $5.0V/2$ to the A/D converter input PE5, which should read full scale if the 5.0V supply should go to 6.6V. This input can be used to check for proper operation of the 5.0V supply as well as determine whether the 3.3V supply is within specification, since the 3.3V supply serves as the reference input to the A/D converter.

The pump's main power supply voltage V_PWR (which can either be 3 to 6 V from the AA batteries or 8V from the power supply) is converted to approximately 6.5V when the unit is running on the batteries. The converter is a step up switching regulator controlled by U4. U4 drives N channel MOSFET transistor U13A on and off, causing current to flow through L1. When U13A shuts off, a flyback voltage is created at the anode of D9, causing current to flow through D9 thus causing C6 to charge up towards the flyback voltage. When C6's voltage is sufficiently high, however, to cause the VFB input to U4 to approach approximately 1.3V, then the EXT output of U4 continues pulsing, causing C6 to start to discharge through the load on the 6-8V supply line. R14 and R15 form a voltage divider to set the output voltage, while C7 causes a phase lead to prevent "hunting" of the voltage control system. D9 prevents from flowing from the 6-8V supply to the lower supply voltage V_PWR when the unit is running on batteries. When the unit is running on the 8V power supply, U4 will not be pulsing, since the VFB pin will now be pulled to a higher voltage than 1.3V. The current from the power supply will then flow through L1 and D9 to the 6-8V supply, resulting in an output voltage one Shottky diode drive below the external supply voltage.

The 6-8V supply is regulated to 5.0V by a linear regulator U3 for use by all components requiring a 5.0V supply. The 5.0V is further regulated by another regulator U6 to 3.3V operation to supply VDD to all devices capable of functioning at 3.3V. C8 filters the output of U3 for stable operation. D10 is a transorb clamping diode which clamps the output voltage of U3 at approximately 5.0V in the event of a malfunction in U3 which could cause its output voltage to go out of regulation. Capacitor C5 is a "supercap" capacitor that is charged through R13 via the 5.0V supply. R13 limits charging current to approximately 50mA, maximum to reduce the load on the 5.0V regulator during power-up. D13 couples the voltage from C5 to the 5.0V bus upon loss of power to allow time for the CPU system to provide an orderly power-down sequence.

C53 is a much larger (1F supercap) capacitor that is utilized to provide power to the CPU and alarm circuit following loss of AC power. C53 is charged through current limiting resistor R150 when Q14 is ON. Q14 is driven when Q15 is ON, whenever there is sufficient voltage at J13 to drive the base of Q15. C53, therefore, is only "fast" charged via R150 when power is present at J13. When the pump is running on batteries connected to J6, C53 is charged more slowly via R155 current limiting resistor. This slow charging scheme is utilized to keep the peak current drains on the battery as low as possible in order to prevent the low battery trip point from being reached prematurely. Both C5 and C53 are discharged when RESET goes high via Q17 and Q16, respectively. Discharging both capacitors at reset prevents multiple resets from occurring and reduces lithium battery standby current quickly. Without the rapid discharge of these capacitors, especially C53, the inputs to the RAM and timer chip can remain in an intermediate state for long periods as the capacitors are discharging. These intermediate state inputs could cause high supply current drains, similar to the condition of floating inputs.

4.3.2.2

Audible Alarm

The audible alarm is a small electromagnetic audio transducer (piezo element on the AIM) which is connected to the circuit board via J12. The audio transducer does not contain its own driver or oscillator circuit, therefore these are provided on the circuit board. For normal alarm conditions, the alarm signal will originate in the 68L11 (main) microprocessor. The alarm drive is provided by this processor's PW3 output. The PW3's duty cycle and frequency can be changed under software control. Increasing the duty cycle from PW3 (up to a point) causes an increase in loudness of the audio transducer.

Under normal conditions, the ALARM line from the watchdog microprocessor is low, making the output of the U35B low, so that U10F's output is high. Gate U26B is thus enabled every time PW3 pulses high. U26C is held high, thus U26A's output pulses in sync with PW3. When U26A pulses high, Q7 turn ON, causing drive to the audio transducer plugged into J12.

Whenever the ALARM line from the watchdog microprocessor is high, and gate U35C's output is high, the backup alarm circuit consisting of U11C, U26C and associated components will be enabled. U35B's output goes high, thus disabling gate U26B and preventing PW3 from having any effect on the audio transducer drive. U11C is part of an RC oscillator circuit that charges and discharges C41 to a voltage level from approximately 5/3 volts to 10/3 volts. U26C outputs a square wave of approximately 2KHz at approximately 50% duty cycle, which in turn drives U26A and Q7 to drive the audio transducer. U35D and U35C together prevent the backup alarm from occurring when the power switch is turned off and reset condition is reached. This scheme prevents the alarm from sounding when the power switch is turned off and reset occurs, to prevent the alarm from sounding when the unit is deliberately turned off.

4.3.2.3**Air and Occlusion Optics Interface**

Port PA4 pulses high periodically for a relatively short duty cycle. When PA4 pulses high, Q9 is turned on by U9C's output going low. Diodes D19 and D20 along with base emitter drop of Q11 provide additional voltage drop to result in a reference across R59 of approximately 3.2 volts. Because the pulsed voltage amplitude across R59 is maintained constant, a constant current pulse will flow through R59 (approximately 40mA). Two separate LED's, one for air and the other for occlusion detection are connected in series to J9-1 and 2. Since the collector current of Q11 is very close to the emitter current, the pulsed current through the LED's is maintained constant. When LED's pulse, the air and occlusion phototransistors, whose collectors are connected to J9-3 and 4, respectively, go into conduction, depending on the amount of light returned via the sensing chambers in the cartridge. When air is present in the cartridge, maximum light will be returned, and the collector of the air transistor will pulse to a low level. The level of the pulse is read via A/D converter input PE0. When a cartridge is present with no occlusion condition, maximum light will be returned to the occlusion phototransistor, and its collector will pulse to the lowest level. The occlusion level is read by A/D input PE1.

4.3.2.4**Motor Drive Circuit**

The pump circuit has the capability of driving the motor either a higher or lower voltage than the battery or supply voltage. The pump circuit uses a buck-boost configuration controlled by the MAX 641 switching regulator U24. When the VFB of U24 input is lower than the internal reference (approximately 1.3V) the EXT output of U24 pulses at approximately 50KHz at up to a 50% duty cycle. When EXT of U24 pulses high, N channel MOSFET transistor U27A is driven ON. At the same time, the output of U25A goes low (to approximately -5.0V), thus driving P channel MOSFET U28 ON. U25A serves as a voltage level translator, converting the 0 to 5.0V swing of U24 EXT output to a -5.0V to V_PWR level swing to properly drive the gate of U28.

When U28 and U27A are ON, the current through L2 begins to increase linearly until U27A and U28 are shut OFF. When these transistors turn off, a flyback voltage appears at the anode of D18 and charges C34 up to a voltage level determined by the speed and torque requirements. Current continues to flow through D17, L2 and D18 after the drive transistors are turned off. Transistor U28 is needed to allow the motor to run at voltages lower than the supply voltage. D17 is needed to allow current to continue to flow through L2 when U28 turns ON. The flyback voltage at the anode of D18 allows voltages much higher than the supply voltage to be delivered to the motor.

The speed input to the motor control circuit is a pulse width modulator output PW1 from the main microprocessor. This pulse width modulated pulse is averaged by R77 and C36 to a D.C. level proportional to the duty cycle of PW1. At 100% duty cycle the voltage across C36 will be 5.0V, since U9E is powered by the 5.0V supply. U11A serves as a noninverting buffer for the D.C. command level at C36. The output of U11A is summed with the output of U23B and a -5.0V offset voltage, via inverting amplifier U23A. As the output of U11A increases in amplitude, the output of U23A decreases in amplitude. As U23A output decreases in amplitude, the VFB input of U24 will be pulled to a lower value, causing the motor drive voltage to increase to maintain servo control. R66 and R68 form a summing junction that sums a portion of the motor voltage with a portion of the voltage from U23A. C33 provides a small amount of phase lead compensation to maintain the stability of the motor servo system and minimize "hunting" effects.

The current through the motor is sampled by R57 and converted to a voltage which is amplified by U23B. The output of U23B can be sampled by the A/D converter as filtered by C54 and R153. As the torque load on the motor increases, the output of U23B increases. R67 and R65 sum U23B's output in the proper ratio via U23A to cause the output drive voltage to increase by just the right amount to maintain the speed of the motor constant. As the output voltage of U23B increases, the output voltage of U23A decreases, forcing the output drive voltage to the motor to a higher level.

The MTR_ON signal from the microprocessor PA6 causes P channel MOSFET U34B to go ON, when PA6 is high. When U34B is on, a switched 5.0V is supplied to U22, U23 and U24. U22 converts the 5.0V to approximately -5.0V, using a charge pump technique, for use in the motor drive circuit. By turning off the switched 5.0V when the motor is not running, power is conserved..

Section 5

Maintenance and Service Tests

This section contains cleaning instructions and the performance verification test (PVT). The PVT is designed to meet the following needs:

☐ **Operation Verification**

The PVT must be performed to verify proper pump operation after any repair or replacement of pump assemblies or components.

☐ **Preventive Maintenance**

As part of a preventive maintenance schedule, it is recommended that the PVT be conducted periodically or per hospital procedures.

☐ **Diagnostics**

The PVT can be used for diagnostic purposes during the troubleshooting of a malfunctioning pump.

5.1

Cleaning the Pump

The pump case exterior and cartridge channel should be kept clean and free of contamination. Establish a routine schedule for cleaning the pump.

WARNING:

Disconnect the pump from AC power prior to cleaning.

CAUTION: To avoid mechanical or electronic damage, do not immerse pump in any fluids or cleaning solutions.

CAUTION: Some cleaning and sanitizing compounds may slowly degrade components made from some plastic materials. Using abrasive cleaners or cleaning solutions not recommended by Abbott Laboratories may result in product damage. Do not use compounds containing combinations of isopropyl alcohol and dimethyl benzyl ammonium chloride.

CAUTION: Do not sterilize by heat, steam, ETO, or radiation. Apply disinfectants to the outside surface of the pump only. Do not use abrasive cleaners or materials on the pump. Using abrasive cleaners or cleaning solutions not recommended by Abbott Laboratories may result in product damage.

CAUTION: To avoid pump damage, cleaning solutions should be used only as directed in the table on the following page. The disinfecting properties of cleaning solutions vary; consult the manufacturer for specific information.

CAUTION: Never use sharp objects such as pens, pencils, fingernails, paper clips, needles, etc., to clean the pump.

Table 5-1. Cleaning Solutions		
Cleaning Solution	Manufacturer	Preparation
Vesphene® Ilse	Calgon Vestal Laboratories	Per manufacturer's recommendation
Manu-Klenz®	Calgon Vestal Laboratories	Per manufacturer's recommendation
Formula C™	Diversey Corporation	Per manufacturer's recommendation
Super Edisonite®	S. M. Edison Chemical Co.	Per manufacturer's recommendation
Household bleach	Various	Per hospital procedures; do not exceed one part bleach in ten parts water

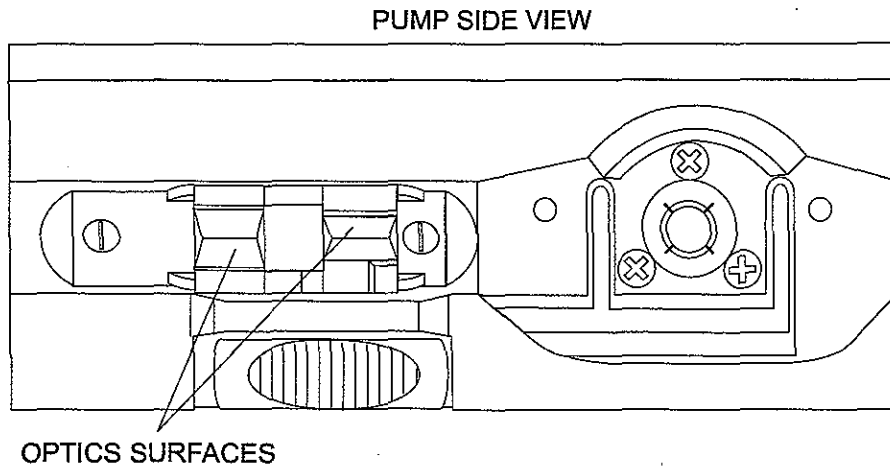


Figure 5-1. Cartridge Channel Detail

□ Clean the pump as follows:

- Clean the exposed surfaces of the pump with a soft, lint-free cloth dampened with the appropriate cleaning solution listed in *Table 5-1. Cleaning Solutions*. The pump is not affected by the appropriate cleaning solutions.
- If the pump has been in an isolation area, disinfect the external surfaces of the pump.

Note: Not all cleaning solutions are disinfectants; check the product labeling.

CAUTION: Do not sterilize by heat, steam, ETO, or radiation, as these methods may cause the pump to malfunction.

- Clean the cartridge channel on a regular basis. Use a moistened cotton swab to clean the optics surfaces (refer to *Figure 5-1. Cartridge Channel Detail*).
- Wipe the solution from the pump surface with a moistened cloth. Do not immerse the pump in fluid. Assure that the optics surfaces are free of detergent film.
- Dry the pump after cleaning.

Note: Wiping the pump free of cleaning solutions helps prevent detergent buildup, which could affect the performance of the pump.

5.2

Inspecting the Pump and Accessories

Periodically perform an external inspection of the pump and accessories for damaged parts and cosmetic defects. Also inspect the pump after repair or during cleaning. Replace assemblies, components, or accessories as required.

5.2.1

Pump Inspection

Inspect the following components:

☐ **Front Case**

- Inspect for cracks or breakage.
- Inspect display window and LCD for damage.
- Inspect the keypads for physical damage.
- Verify smooth power switch operation.
- Inspect bolus and power jacks for excessive wear or damage.
- Verify presence and legibility of BOLUS, 8 VDC, and ON/OFF labels.

☐ **Back Case**

- Inspect for cracks or breakage.
- Verify VOID label is intact.
- Inspect to verify presence of closure hardware.
- Verify presence and legibility of operating and serial number labels.

☐ **Motor Frame Assembly (includes Optics and Latch Assemblies)**

- Verify motor frame is free from scratches, discoloration, or contamination.
- Inspect to insure that motor shaft extension is present and firmly attached to motor shaft.
- Rotate motor shaft clockwise to insure smooth rotation.
- Verify presence of motor mount screws.
- Verify dowel pin presence and condition.
- Inspect to insure latch engagement operates smoothly without binding.
- Verify presence and condition of cartridge hold-down tab.
- Install test cartridge to verify latch hold-down tab engages cartridge tab and correctly seats over optics carrier.
- Inspect optic carrier for excessive scratches and/or contamination.
- Verify presence of optic retention screws.

❑ Battery Compartment

- Verify presence of battery door and condition of PCB contact.
- Inspect legibility of battery polarity labels.
- Verify condition of battery contacts.
- Inspect door/case interface for cracks and breakage.
- Install batteries, move power switch to ON position and insure unit enters self diagnostic mode.

5.2.2**Accessories Inspection**

Inspect the accessories as follows:

❑ Rechargeable Battery Pack

- Ensure that the pack slides fully into place and that it locks firmly to the pump.
- Slide the ON/OFF switch to ON and verify that the unit powers on. Slide the switch to the OFF position.

❑ AC Power Supply

- Check the cord for damage or fraying; confirm a connection to the adapter box.
- Remove the batteries. Connect the AC power adapter to the power jack. Verify that the connector fits firmly into the power jack.
- Slide the ON/OFF switch to ON and verify that the unit powers on.
- Verify that the alarm LED (next to the alarm icon) flashes on, then off. Verify that the AC power LED (next to the plug icon) flashes on and remains lit. Slide the switch to the OFF position.

❑ Remote Bolus Cord and Switch

- Confirm a connection and check the cord and bolus switch for damage.
- Verify that the connector fits firmly into the bolus jack.
- Verify that bolus plug pin is not bent.

❑ Printer and Printer Cable

- Inspect the printer cable for damage.
- Inspect the connections to the pump and printer; check the pins for damage.
- Inspect the printer following the manufacturer's recommendations.

5.3

Performance Verification Test (PVT)

The PVT consists of five tests: the Electrical Test, the Delivery Test, the Optics Test, the Current Supply Test, and the Burn-In Test. The Preparation for Use procedure clears the testing data from the pump's memory.

The PVT Form, located at the end of this section, may be used to record the PVT results. To use the PVT, copy the form and fill in the pump model (AIM or AIM Plus) and serial number.

For more information regarding any alarms that occur or other abnormal performance detected during the PVT, refer to *Section 6, Troubleshooting*.

☐ **Electrical Test**

Uses the pump's software diagnostic mode to perform a final acceptance test procedure (ATP).

☐ **Delivery Test**

Verifies the motor operation through a "dry" test that measures motor turns or through a "wet" test that measures fluid delivered.

☐ **Optics Test**

Verifies correct operation of the optics by generating occlusion and air-in-line alarms.

☐ **Current Supply Test**

Verifies proper current drain for acceptable battery life.

☐ **Burn-In Test**

Verifies correct operation of the pump over 24 hours without alarms.

This test is not required, but is recommended by the manufacturer. Consult facility requirements to determine if this test is required.

☐ **Preparation for Use**

Clears the NVRAM and error logs. Always complete this section before releasing the pump for patient use.

CAUTION: Many test steps are dependent on the correct outcome of steps previously performed; therefore, all tests are to be performed in the order presented to assure accurate results. If test results for a step do not meet the parameters given in this manual, stop testing, rework the pump, and start testing from the beginning of the PVT.

5.3.1

PVT Equipment

The PVT requires a power source, the electrical test setup, and the wet test setup as detailed below. The optics test block and turns counter are available as alternatives to wet testing.

Equipment available from standard sources:

- ☐ Digital multimeter (DMM), Fluke® Model 77, or equivalent
- ☐ Seiko® DPU411, DPU414 or Kodak Diconix 150 Plus printer (if printout of electrical test desired), (refer to *System Operating Manual for Printer Setup*)
- ☐ Four AA batteries
- ☐ "Wet" test setup (if optics block, turns counter, or torque brake are not available)
 - Quick-Load™ cartridge set
 - 20 mL graduated cylinder w/0.2mL graduations
 - Fluid reservoir

Equipment available from Abbott Laboratories (refer to the *Spare Parts Price List*):

- ☐ 5-8V microbox with 12V power supply, battery substitution block, and AC substitution cable
- ☐ Battery substitution block
- ☐ AC substitution cable
- ☐ 3.6 oz-in torque brake fixture with 18V power supply
- ☐ Optics test block
- ☐ Turns counter with 12V power supply and cartridge housing
- ☐ Printer cable for Seiko or Kodak printers (if printout of electrical test desired)
- ☐ Cartridge housing (for use with turns counter and current supply test)
- ☐ AC power supply list 13586 (if desired for 24-hour burn-in test)
- ☐ Quick-Load™ cartridge set (for "wet" test if optics block, turns counter, or torque brake are not available)

5.3.2

Electrical Test

This test uses the pump's software diagnostic mode to perform a final acceptance test procedure (ATP). The AIM and AIM Plus share the same Service Mode Diagnostic with the following exceptions: the Keypad Test for the AIM Plus requires an exact sequence of key presses and AIM Plus contains an Encoder Test while the AIM does not. These differences are noted again under the specific test sections.

5.3.2.1

Recording Test Results

The pump will display a message asking you to respond YES for PASS or NO for FAIL after each step of the electrical test is completed. These answers are logged to the pump's memory and may be printed at the end of the test. This printout may be attached to the PVT Data Form (refer to *Section 5.3.8*) as part of the test record. There is also space provided on the PVT Data Form for recording this information, if desired.

5.3.2.2

Test Setup

For test setup diagram, refer to *Figure 5-2. Basic Equipment Setup.*

1. Connect microbox to the DMM.
2. Connect the 12V power supply to the 12V IN jack on the microbox.
3. Insert battery substitution block into the pump's battery compartment (battery door only partially closes over inserted block).
4. Insert barrel plug from battery substitution block into BATT BLOCK jack on the microbox.
5. Attach barrel plug from EXT POWER jack of microbox to AC power jack of the pump.

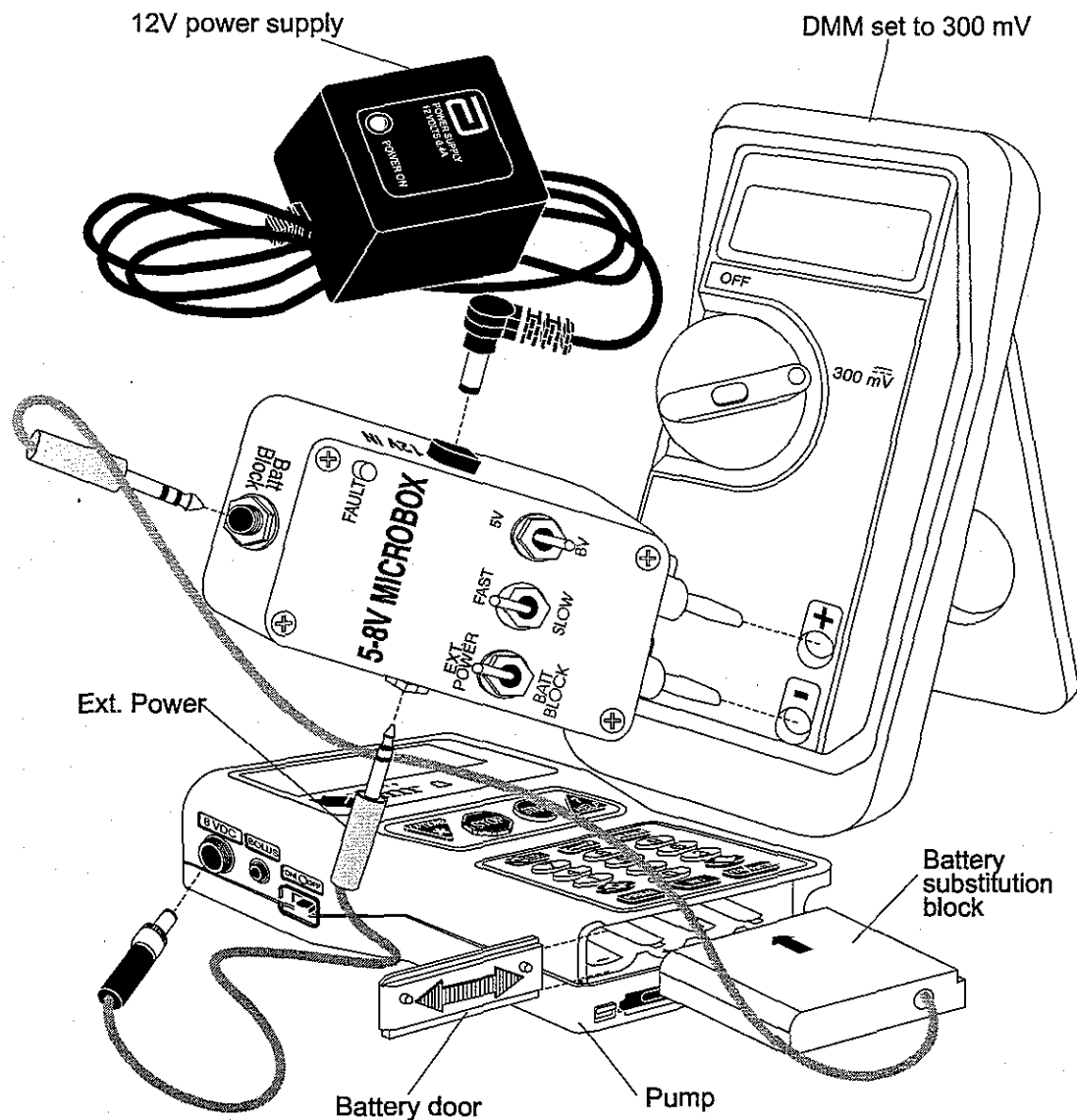


Figure 5-2. Basic Equipment Setup

6. Make the following adjustments to the microbox switches:

- Turn the pump power selector to EXT. POWER.
- Turn voltage selector to 8V.
- Turn filter switch to SLOW.

5.3.2.3

Entering the Service Test Mode

The Service Test Mode is entered by completing the steps below during the initial self-test.

If the steps are not completed as directed, the pump will not enter the Service Test Mode but instead will complete the self-test as usual. If the [OPTIONS] key is held down too long, System Error Code 100 will occur, which indicates a stuck key. In either case, power off the pump, wait several seconds, then power on again and repeat the steps as indicated.

Power on the pump to initiate the self-test.

```
UNIT SELF-TEST
  IN PROGRESS
TIME IS ##:## XM
  DDD, MMM DD, YY
```

After approximately 12-15 seconds the pump will beep once. **Immediately** after the beep press and **hold** the [OPTIONS] key.

```
KEYPAD CHECK
  RELEASE KEY
TIME IS ##:## XM
  DDD, MMM DD, YY
```

Continue to hold [OPTIONS] while this alarm message flashes on the first two lines and the beeper sounds.

Continue to hold the key until the following display appears:

```
ENTER THE LOCK
SEQUENCE NUMBER
```

Release [OPTIONS] and use the numeric keypad to enter the pump's list number to access the Service Test Mode.

AIM: [1] [3] [0] [3] [8]

AIM Plus: [1] [3] [9] [6] [7]

5.3.2.4

Selecting the Final ATP Test

```
01 VERSION #
02 CLEAR EXT RAM
03 CLEAR ERR LOG
USE * FOR MORE
```

Press [2] [1] to select ATP TESTS (you do not have to be displaying the line to enter a selection).

```
SELECT ATP TEST
1 BOARD TEST
2 FINAL TEST
```

Press [2] to select FINAL TEST.

```
PUMP
SERIAL NUMBER
*****
PRESS NO TO EXIT
```

Enter the pump's serial number (on back label).

Press [NO] to exit.

5.3.2.5

Set Clock

```
TIME IS 10:42 AM
SAT, AUG 03, 96
* KEY TO CHANGE
PRESS NO TO EXIT
```

If time and date are correct, press [NO] to exit.

If a change is necessary, press the [OPTIONS] key and follow the instructions on the display to enter the correct information. Press [NO] to exit when the clock is correct.

```
SET CLOCK
'YES' = PASS/NEXT
'NO' = FAIL/QUIT
or 'BACKUP'
```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP (Acceptance Test Procedure), or press [BACK-UP] to repeat the test.

5.3.2.6

Software Version Verification

```
VERSION NUMBERS
MAIN      #.###
SAFETY    #.###
PRESS NO TO EXIT
```

Record the MAIN and SAFETY software version numbers on the PVT Form.

```
VERSION #
'YES' = PASS/NEXT
'NO' = FAIL/QUIT
or 'BACKUP'
```

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.7

Supply Check

```
SUPPLY CHECK
EXT AC #.##V ###
REG 5V #.##V ###
PRESS NO TO EXIT
```

PLEASE WAIT will display while the pump performs the supply check. PRESS NO TO EXIT appears when the check is complete.

Verify the EXT AC reading is 7.60 - 8.40V.

Verify the REG 5V reading is 4.80 - 5.20V

Press [NO] to exit.

```
SUPPLY CHECK
'YES' = PASS/NEXT
'NO' = FAIL/QUIT
or 'BACKUP'
```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.8**Display Test**

```
0123456789ABCDEF
GHIJKLMNOPQRSTU
VWXYZabcdefghijk
lmnopqrstuvwxyz
```

Verify the display appears as shown here.

Press [NO] to exit.

```
DISPLAY TEST
'YES' = PASS/NEXT
'NO' = FAIL/QUIT
or 'BACKUP'
```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.9**Contrast Adjust**

```
ADJUST CONTRAST
0.04V
BACKLIGHT OFF
PRESS NO TO EXIT
```

Use the arrow keys to increase and decrease the voltage. Verify that the screen fades as the voltage increases.

Press [CHANGE] to set the contrast to 0.04V (manufacturer's recommendation for highest contrast).

```
ADJUST CONTRAST
0.04V
BACKLIGHT ON
PRESS NO TO EXIT
```

Press [5] and verify that the backlight stays on and message says "ON".

Press [2] and verify that the message switches to "OFF" and the backlight goes off after five seconds.

Press [NO] to exit.

```
CONTRAST ADJ
'YES' = PASS/NEXT
'NO' = FAIL/QUIT
or 'BACKUP'
```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.10**LED Test**

```
LED CHECK
ALARM LED    ON
POWER LED    ON
PRESS NO TO EXIT
```

Press [1] to turn the ALARM LED OFF, then press [4] to turn the ALARM LED ON.

Press [2] to turn the POWER LED OFF, then press [5] to turn the POWER LED ON.

Press [NO] to exit.

```
LED TEST
'YES' = PASS/NEXT
'NO' = FAIL/QUIT
or 'BACKUP'
```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.11

Keypad Test

KEYPAD TEST
NO KEY PRESS 23

PRESS NO TO EXIT

Note: The AIM Plus is sequence-sensitive and will indicate a failure if the keys are not pressed in the order described below.

Moving **left to right and top to bottom**, press and hold each key once and verify that the name of the key is displayed while the key is held.

On the front of the pump, start with [OPTIONS] and end with [YES/ENTER]. Then, on top of the pump, press [BOLUS] once, then insert the remote bolus cord and press the button on the cord. (If no remote bolus cord is available, press [BOLUS] twice.)

Press and **hold** [NO] for approximately 3 seconds to exit.

AIM instructions:

KEYPAD CHECK
'YES' = PASS/NEXT
'NO' = FAIL/QUIT
or 'BACKUP'

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

AIM Plus instructions:

If the "KEYPAD TEST FAILED" message appears, press [BACK-UP] and start the test again, being sure to press each key in the order described.

Abbott AIM Plus
FINAL TEST
→→→→ NEXT →→→→

If pump passes the keypad test, this message appears while [NO] is held. Release [NO]. No response required; pump advances automatically.

If using the PVT Form, record the results.

5.3.2.12**Battery Check****□ Test Setup:**

- Turn the pump power selector on the microbox to BATT BLOCK.
- Turn voltage selector on the microbox to 5V.
- Verify that the microbox LED is off.

```

BATTERY CHECK
ALK      #.##V ###
LITH     #.##V ###
PRESS NO TO EXIT

```

PLEASE WAIT will display while the pump performs the battery check. PRESS NO TO EXIT appears when the check is complete.

Verify the ALK reading is 4.60 - 5.16V.

Verify the LITH reading is 2.79 - 3.50V.

Press [NO] to exit.

```

BATTERY CHECK
'YES' = PASS/NEXT
'NO'  = FAIL/QUIT
      or 'BACKUP'

```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.13**Idle Current**

```

IDLE CURRENT

          ## mA
PRESS NO TO EXIT

```

Verify the idle current on the DMM is 30 mA or less (1 mV on the meter = 1 mA current).

Press [NO] to exit.

```

IDLE CURRENT
'YES' = PASS/NEXT
'NO'  = FAIL/QUIT
      or 'BACKUP'

```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.14**Optics Check I**

OPTICS CHECK	
AIR	###
OCCL	###
PRESS NO TO EXIT	

Verify the AIR reading is 231 - 255
 Verify the OCCL reading is 231 - 255.

Press [NO] to exit.

AIR/OCCL TEST	
'YES'	= PASS/NEXT
'NO'	= FAIL/QUIT
or 'BACKUP'	

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.15**Optics Check II**

The second portion of the Optics Check requires an optics test block. If an optics test block is not available, press [NO] to exit, then [YES] to go to the next test.

❑ Test Setup (refer to *Figure 5-3. Optics Test Block Placement*):

- Check the optics test block to ensure that the optical surfaces are clean and not scratched.
- Position the pump with the cartridge channel facing up.
- Insert the optics test block into the optics carrier. The arrows must be pointing toward the bottom of the pump.

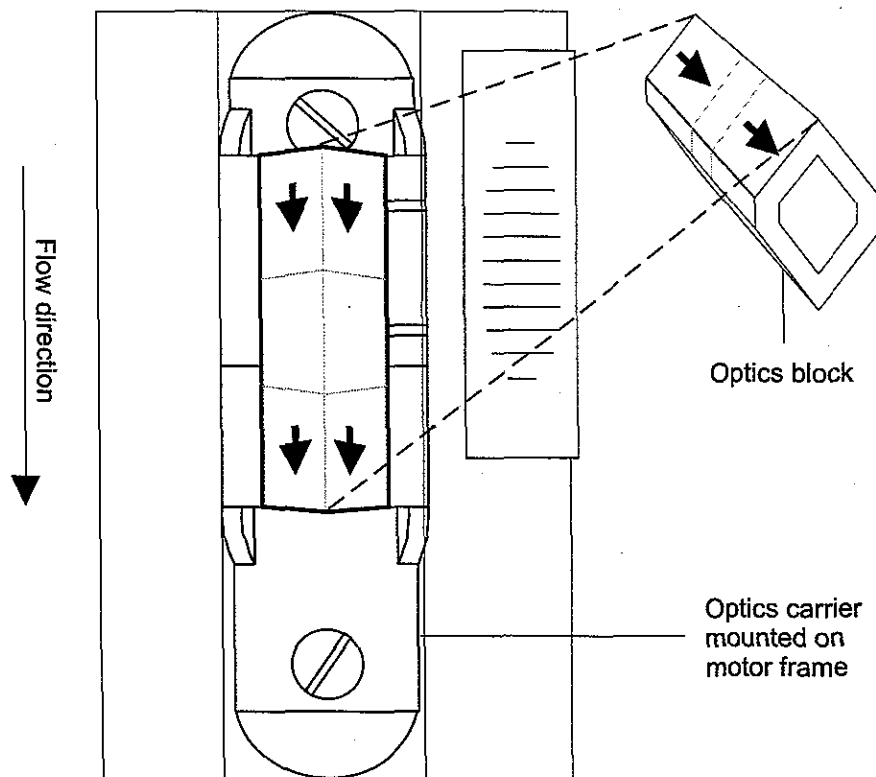


Figure 5-3. Optics Test Block Placement

5F-4B_4

```

OPTICS CHECK
AIR    ##
OCCL   ##
PRESS NO TO EXIT

```

Verify the AIR reading is 14 - 40
 Verify the OCCL reading is 12 - 40.

Press [NO] to exit.

```

AIR/OCCL TEST
'YES' = PASS/NEXT
'NO'  = FAIL/QUIT
      or 'BACKUP'

```

Remove the test block.

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.16

Clearing the Memory

```

CLEARING EXT RAM
ADDRESS:    ####
           PLEASE WAIT

```

The pump clears the external RAM chip. As the test proceeds, the address changes.

No user response required; pump automatically advances.

```

CLEARING
ERROR LOGS
ADDRESS:    ####
           PLEASE WAIT

```

The pump clears the error logs. As the test proceeds, the address changes.

No user response required; pump automatically advances.

```

INITIALIZING
INTERNAL NVRAM
ADDRESS:    ####
           PLEASE WAIT

```

The pump clears the NVRAM chip. As the test proceeds, the address changes.

No user response required; pump automatically advances.

5.3.2.17**Beeper Test**

6811↓	6805↓
*DUTY CYCLE	50%
FREQ.	2.23 kHz
ENTER=>DUTY/FREQ	

Press [6] to enable chip 6805. Verify that the arrow switches from down to up and that the beeper sounds. Press [3] to disable 6805. Verify that the beeper goes off and that the arrow switches to the down position. (Note: the display examples shown here represent the AIM Plus.)

Press [5] to enable chip 6811.

6811↑	6805↓
*DUTY CYCLE	###
FREQ.	2.23 kHz
ENTER=>DUTY/FREQ	

Verify that the arrow next to 6811 switches from down to up and that the beeper sounds continuously.

While the beeper is on, press [OPTIONS] and verify that the beeper volume goes up and down as the duty cycle runs between 0 - 50%.

Press [OPTIONS] again to stop the cycling, then use the arrow keys to set the duty cycle to the loudest sound - approximately 50% (individual beepers may vary).

Press [YES/ENTER] to switch the asterisk down to the frequency entry.

6811↑	6805↓
DUTY CYCLE	50%
*FREQ.	#.## kHz
ENTER=>DUTY/FREQ	

Use the arrow keys to set the frequency to the loudest sound: AIM should be 4 kHz, AIM Plus should be 2.00 - 2.30 kHz.

Press [2] to disable 6811. Verify that the beeper goes off and that the arrow switches to the down position.

Press [NO] to exit.

BEEPER TEST	
'YES' = PASS/NEXT	
'NO' = FAIL/QUIT	
or 'BACKUP'	

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.18**Motor Test**

Perform either Dry or Wet Test.

☐ **Dry Test Setup:**

- Attach the torque brake fixture to the pump's motor shaft extension.
- Turn on the torque brake.

☐ **Wet Test Setup:**

- Attach a primed PROVIDER set to the pump's motor shaft extension.

```
PW1: 000  I: 017
RPM:      MV: 000
           SV: 001
WDG 6811↓ 6805↓
```

Press [5] and [6] to enable chips 6811 and 6805.

Press and hold the up arrow to increase PW1 to 230. Verify that the motor speed increases smoothly and that the shaft is turning clockwise.

```
PW1: 230  I: ##
RPM: ###  MV: ###
           SV: 001
WDG↑ 6811↑ 6805↑
```

Press [3] to disable 6805. Verify that the motor turns off.

Press [6] to enable 6805. Verify that the motor turns on.

Verify that the SUPPLY CURRENT reading on the DMM is 210 mA or less (1 mV = 1 mA).

Verify that the I (motor current) reading is 115 or less.

Verify that the RPM reading is 76.0 - 97.0 (third digit is 10ths).

Press [OPTIONS] twice to record the test data to memory.

Press [2] to disable 6811. Verify that the motor turns off. Press [NO] to exit.

```
MOTOR TEST
'YES' = PASS/NEXT
'NO'  = FAIL/QUIT
      or 'BACKUP'
```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

5.3.2.19**Servo Calibration**

```

SELECT MOTOR
1 PORTESCAP
2 MICRO MO

```

Press [1] to select PORTESCAP.

```

START MOTOR
CALIBRATION?
PRESS YES TO
CONTINUE

```

Press [YES] to begin calibration.

```

SERVO CAL DIAG
TESTING ###

##

```

The pump starts the motor, increases the duty cycle, measures the motor speed, and measures the motor current at intervals. The pump then determines the linearity of the relationship between the duty cycle set and the actual motor speed.

If an error code is displayed, refer to *Section 6.3.3, Servo Calibration Failure Codes*, for troubleshooting information.

```

SERVO CAL DIAG
COMPLETE
MD LR ILO IHI
SLOPE INTRC ERR

```

Verify the following readings:

MD	= 50 - 75	(minimum duty cycle)
LR	= >25	(lowest rate)
ILO	= 200 - 450	(minimum current with torque brake)
(or)	= 100 - 450	(minimum current with primed set)
IHI	= 275 - 600	(maximum current with torque brake)
(or)	= 175 - 600	(maximum current with primed set)
SLOPE	= 3109 - 4505	(slope of the line)
INTRC	= 4866 - 5806	(intercept of the line)
ERR	= 0 - 1	(line error)

```

SERVO CAL DGN
'YES' = PASS/NEXT
'NO' = FAIL/QUIT
or 'BACKUP'

```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

Disconnect the torque brake fixture from the pump's motor shaft extension or remove primed set from motor frame.

Note: Do not clear NVRAM after calibrating the motor, as this will clear the motor constants obtained.

5.3.2.20**Encoder Test - AIM Plus Only**

The AIM Plus Encoder Test requires a turns counter and cartridge housing or primed PROVIDER set and 20 mL graduated cylinder.

Perform either Dry or Wet Test.

☐ **Dry Test Setup (with turns counter):**

- Install the cartridge housing on the motor frame to defeat the occlusion and check cartridge alarms.
- Connect the turns counter to the pump's motor shaft extension.
- Press RST on the turns counter to reset the display to 0.0.

☐ **Wet Test Setup (with primed PROVIDER set):**

- Install a primed set into the motor frame.
- Place the proximal end of the set into a water source.
- Place the distal end of the primed set into the mouth of a 20 mL graduated cylinder.

```
ENCODER TEST
  0.0mL INFUSED
PRESS START
PRESS NO TO EXIT
```

Press [START] to begin delivery. The volume infused will begin to accrue.

Pump will run until 20 mLs are delivered.

```
RATE:###.# mL/hr
  20.0mL INFUSED
TIME: 179 sec
PRESS NO TO EXIT
```

Verify that the RATE reading is 396.0 - 404.0 mL/hr.

Verify that the TIME reading is 178 - 182 seconds.

For Dry Test:

Verify that the turns counter volume reading is 19.8 - 20.2 mL.

For Wet Test:

Verify that the volume delivered to cylinder is 19.8 - 20.2 mL.

Press [NO] to exit.

```
ENCODER TEST
'YES' = PASS/NEXT
'NO'  = FAIL/QUIT
      or 'BACKUP'
```

If using the PVT Form, record the results.

Press [YES] to indicate PASS and go to the next test, [NO] to exit the FINAL ATP, or press [BACK-UP] to repeat the test.

Press [YES] to exit the FINAL ATP.

5.3.2.21

Print Test Results

☐ **Test Setup:**

- Connect the printer to the pump (for setup instructions, refer to the *System Operating Manual*).

```
PRINT ATP TESTS:
CONNECT PRINTER
AND PRESS START.
STOP TO CANCEL.
```

Press [START] to print the test results.

Attach the printout to the PVT.

5.3.2.22

Printer Test

```
01 VERSION #
02 CLEAR EXT RAM
03 CLEAR ERR LOG
USE * FOR MORE
```

At the Service Test Mode menu press [1] [7] to enter the PRINTER TEST.

The pump will send a copy of the character set to the printer. Verify the printout reads as follows:

```
PRINT TEST START
```

```
ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
opqrstuvwxyz0123456789.:_* ,µABCDEFGHIJKL
MNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz
0123456789.:_* ,µABCDEFGHIJKLMN OPQRSTUVWXYZ
```

```
PRINT TEST COMPLETE
```

Attach the printout to the PVT.

5.3.2.23

Power Loss Alarm

Disconnect the external power supply and battery substitution block. Verify that the power loss alarm sounds for at least 30 seconds. If using the PVT Form, record the results.

5.3.3**Delivery Test**

This test verifies the motor operation through a “dry” test that measures motor turns or through a “wet” test that measures fluid delivered.

5.3.3.1**Pump programming**

Install four AA batteries. Switch the pump on and wait for the self-test to complete. Because only batteries are in use, the following display appears:

USING BATTERIES

Press [ENTER].

ENTER TO CONFIRM

1 TPN
2 PAIN MANAGEMNT
3 INTERMITTENT
USE ↓ FOR MORE

Press [2] to select pain management therapy.

1 INTRAVENOUS
2 EPIDURAL
3 SUBCUTANEOUS

Press [2] to select epidural mode.

1 CONTINUOUS
2 BOLUS ONLY
3 CONT. + BOLUS

Press [2] to select bolus only delivery.

1 SELECT mg/mL
2 SELECT µg/mL
3 SELECT mL

Press [3] to select mL as the delivery unit.

PROGRAM A
LOADING DOSE?

Press [YES] to program a loading dose.

YES OR NO

SET LOADING DOSE

For Dry Test: Press [1] [0] and [ENTER] to select 10 mL.

0.0 mL

For Wet Test: Press [2] [0] and [ENTER] to select 20 mL.

ENTER WHEN DONE

DELIVER THE
LOADING DOSE
NOW?
YES OR NO

Press [NO] to save the loading dose for later delivery.

SET BOLUS DOSE

0.0 mL
ENTER WHEN DONE

Press [1] and [ENTER] to select a 1 mL bolus dose.

BOLUS LOCKOUT

0 MINUTES
ENTER WHEN DONE

Press [5] and [ENTER] to select a 5 minute bolus lockout.

DOSE LIMIT
1 4 HOUR LIMIT
2 # BOLUSES/HOUR
3 NO DOSE LIMIT

Press [3] to set no dose limit.

CONTAINER SIZE

0.0 mL
ENTER WHEN DONE

Press [1] [0] [0] [ENTER] to select a 100 mL container size.

AIR SENSITIVITY
1 HIGH
2 LOW
3 AIR ALARM OFF

Press [3] to turn the air alarm off.

USING AN AIR
ELIMINATING
FILTER?
YES OR NO

Press [YES].

PROGRAM
REVIEW

USE ↓ FOR MORE

Press and hold the down arrow key to scroll through the program parameters until the review is complete.

At the last screen, press [ENTER] to exit the program review.

SAVING PROGRAM

No response required. Pump enters the stop mode.

5.3.3.2

Test Setup

Use the dry or wet test setup depending on the equipment available. Refer to *Section 5.3.1, PVT Equipment*, for the Delivery Test equipment list.

Dry Test Setup

1. Install the cartridge housing on the motor frame to defeat the occlusion and check cartridge alarms.
2. Connect the turns counter to the pump's motor shaft extension.

3. Connect the 12V power supply to the turns counter. Press RST on the turns counter to reset the display to 0.0.

Wet Test Setup

1. Install a primed cartridge set into the pump. If necessary, refer to the pump's *System Operating Manual* for detailed instructions regarding cartridge installation and priming.
2. Position the proximal end of the tubing in the beaker of water and the distal end in a 20 mL graduated cylinder to measure the liquid delivered.

5.3.3.3

Test Procedure

0.0mL INFUSED

PRESS START
TO INFUSE

In the stop mode, press [START].

DELIVER THE
LOADING DOSE
NOW?
YES OR NO

Press [YES] to begin delivery of the Loading Dose.

#.#mL INFUSED
DELIVERING
LOADING DOSE
■■■■■■■

Verify that the motor begins turning clockwise and that the volume infused accrues on the screen (delivery rate 125 mL/hr).

The pump requires approximately five minutes to deliver the 10 mL dose or ten minutes to deliver the 20 mL dose. When the loading dose delivery is complete, the pump returns to the stop mode.

For Dry Test: Verify that the display on the turns counter is between 9.95 and 10.05 mL. If using the PVT Form, record the results. Disconnect the turns counter from the pump.

For Wet Test: Verify that the total amount of fluid in the container is between 19.0 and 21.0 mL. If using the PVT Form, record the results.

5.3.4

Optics Test

This test verifies correct operation of the optics by generating an occlusion and an air-in-line alarm.

5.3.4.1

Pump Programming

10.0mL INFUSED

PRESS START
TO INFUSE

Press [CHANGE].

1 REVIEW/RESUME
2 NEW CONTAINER
3 NEW PROGRAM
4 CHANGE PROGRAM

Press [3] to select new program.

1 TPN
2 PAIN MANAGEMNT
3 INTERMITTENT
USE ↓ FOR MORE

Press [2] to select pain management therapy.

1 INTRAVENOUS
2 EPIDURAL
3 SUBCUTANEOUS

Press [2] to select epidural mode.

1 CONTINUOUS
2 BOLUS ONLY
3 CONT. + BOLUS

Press [3] to select continuous plus bolus delivery.

1 SELECT mg/mL
2 SELECT µg/mL
3 SELECT mL

Press [3] to select mL as the delivery unit.

SET RATE

0.0 mL/hr
ENTER WHEN DONE

Press [2] [5] and [ENTER] to select a 25 mL/hr rate.

PROGRAM A
LOADING DOSE?

YES OR NO

Press [NO].

SET BOLUS DOSE

0.0 mL
ENTER WHEN DONE

Press [1] and [ENTER] to select a 1 mL bolus dose.

BOLUS LOCKOUT

0 MINUTES
ENTER WHEN DONE

Press [5] and [ENTER] to select a 5 minutes bolus lockout.

DOSE LIMIT
1 4 HOUR LIMIT
2 # BOLUSES/HOUR
3 NO DOSE LIMIT

Press [3] to set no dose limit.

CONTAINER SIZE

0.0 mL
ENTER WHEN DONE

Press [1] [0] [0] [ENTER] to select a 100 mL container size.

AIR SENSITIVITY
1 HIGH
2 LOW
3 AIR ALARM OFF

Press [1] to select high air sensitivity.

USING AN AIR
ELIMINATING
FILTER?
YES OR NO

Press [YES].

PROGRAM
REVIEW

USE ↓ FOR MORE

Press and hold the down arrow key to scroll through the program parameters until the review is complete.

At the last screen, press [ENTER] to exit the program review.

SAVING PROGRAM

No response required. Pump enters the stop mode.

5.3.4.2

Test Setup

1. Install a primed cartridge set into the pump. If necessary, refer to the pump's *System Operating Manual* for detailed instructions regarding cartridge installation and priming.
2. Position the proximal end of the tubing in the beaker of water and the distal end in a container to capture the liquid delivered.
3. Occlude the distal end of the set by clamping off the tubing.

5.3.4.3

Test Procedure

0.0mL INFUSED
RATE 25.0mL/hr
PRESS START
TO INFUSE

In the stop mode, press [START].

#.#mL INFUSED
RATE 25.0mL/hr

OCCLUSION

Wait for the alarm to occur.

Verify that OCCLUSION flashes on the display, the alarm LED flashes and the alarm sounds. If using the PVT Form, record the results.

Press [SILENCE] to quiet the alarm. Press [STOP] to return to the stop mode.

Clear the occlusion by removing the clamp from tubing. Remove the cartridge set from the pump and clear fluid from the tubing. Install the dry set in the pump.

Press [START].

#.#mL INFUSED
DELIVERING
LOADING DOSE
AIR IN LINE

Wait for the alarm to occur.

Verify that AIR IN LINE flashes on the display, the alarm LED flashes and the alarm sounds. If using the PVT Form, record the results.

Press [SILENCE] to quiet the alarm. Press [STOP] to return to the stop mode.

#.#mL INFUSED
RATE 25.0mL/hr
PRESS START
TO INFUSE

Press [OPTIONS].

1 REVIEW PROGRAM
2 HISTORY
3 KEYPAD LOCK
USE ↓ FOR MORE

Press [4] to select AIR SENSOR (the line does not need to be on the screen to be chosen).

AIR SENSITIVITY
1 HIGH
2 LOW
3 AIR ALARM OFF

Press [3] to turn the air alarm off.

USING AN AIR
ELIMINATING
FILTER?
YES OR NO

Press [YES].

CHANGE AIR ALARM
FROM HIGH
TO OFF?
YES OR NO

Press [YES].

0.0mL INFUSED
RATE 25.0mL/hr
PRESS START
TO INFUSE

Press [PRIME].

Follow the instructions on the display to prime approximately 1.0 mL to clear the air alarm. If necessary, refer to the pump's *System Operating Manual* for detailed instructions regarding priming.

5.3.5

Current Supply Test

This test verifies proper current drain for acceptable battery life.

5.3.5.1

Test Setup

1. Turn the power switch off, allow the pump to power down completely, and remove the batteries. Remove the cartridge set.
2. Set up the DMM and microbox as described for the Electrical Test in *Section 5.3.2.2, Test Setup*, and as shown in *Figure 5-2. Basic Equipment Setup*.
3. Make the following adjustments to the microbox switches:
 - Turn the pump power selector to BATT BLOCK.
 - Turn voltage selector to 5V.
 - Turn filter switch to SLOW.
4. Use the torque brake to apply a 3.6 oz-in load to the motor shaft. A dry or wet set may be used as a substitute for the torque brake. If torque brake is used, install the cartridge housing on the motor frame to defeat the occlusion and check cartridge alarms.

5.3.5.2

Test Procedure

Switch the pump on and wait for the self-test to complete.

USING BATTERIES

Press [ENTER].

ENTER TO CONFIRM

CURRENT THERAPY:
PAIN MGMT EPIDRL
USE CURRENT?
YES OR NO

Press [YES] to use the current therapy.

If the Options menu appears, press [1] to select REVIEW/RESUME. Use the arrow keys to review the program, then press [ENTER] to go to the stop mode.

0.0mL INFUSED
RATE 25.0mL/hr
PRESS START
TO INFUSE

In the stop mode, press [START].

#.#mL INFUSED
RATE 25.0mL/hr

Press [BOLUS] (on the top of the pump) to begin bolus delivery.

■■■■■■■

Allow the current to stabilize before reading the DMM.

Verify that the SUPPLY CURRENT reading on the DMM is 75 mA or less ($1 \text{ mV} = 1 \text{ mA}$). If using the PVT Form, record the results.

Turn the power switch off, allow the pump to power down completely, and remove the battery substitution block. Disconnect the torque brake and remove the cartridge housing.

5.3.6

Burn-In Test

This optional test verifies correct operation of the pump over 24 hours without alarms.

Note: This test is recommended but not required.

5.3.6.1

Test Setup

1. Install four (4) AA batteries or power supply list 13586.
2. Install the test cartridge into the pump.

5.3.6.2

Test Procedure

Switch the pump on and wait for the self-test to complete. Because only batteries are in use, the following display appears:

```

USING BATTERIES

ENTER TO CONFIRM
    
```

Press [ENTER].

```

CURRENT THERAPY:
PAIN MGMT EPIDRL
USE CURRENT?
YES OR NO
    
```

Press [NO] to enter a new therapy.

```

1 TPN
2 PAIN MANAGEMNT
3 INTERMITTENT
USE ↓ FOR MORE
    
```

Press [5] to select continuous therapy.

```

SET RATE

400.0 mL/hr
ENTER WHEN DONE
    
```

Press [4] [0] [0] and [ENTER] to select a 400 mL/hr rate.

```

CONTAINER SIZE

6400.0 mL
ENTER WHEN DONE
    
```

Press [6] [4] [0] [0] [ENTER] to select a 6400 mL container size.

```

AIR SENSITIVITY
1 HIGH
2 LOW
3 AIR ALARM OFF
    
```

Press [3] to turn the air alarm off.

USING AN AIR
ELIMINATING
FILTER?
YES OR NO

Press [YES].

PROGRAM
REVIEW

Press and hold the down arrow key to scroll through the program parameters until the review is complete.

USE ↓ FOR MORE

At the last screen, press [ENTER] to exit the program review.

0.0mL INFUSED
RATE 400.0mL/hr
PRESS START
TO INFUSE

In the stop mode, press [START] to begin delivery.

Allow the pump to run for 16 hours. The ALMOST EMPTY alarm sounds approximately 30 minutes before the 16-hour period elapses. Press [SILENCE] to mute the audible alarm for 10 minutes.

6400.0mL INFUSED
RATE 400.0mL/hr

EMPTY CONTAINER

When the delivery is complete, verify that EMPTY CONTAINER flashes on the display.

Turn the power switch off.

If using the PVT Form, record the results. Investigate any alarms or abnormal performance and make any repairs that may be necessary. If additional repairs are required, it is strongly recommended that the entire PVT be performed again.

5.3.7**Preparation for Use**

After testing is completed, initialize the NVRAM and clear the logs to prepare the pump for use.

Power on the pump to initiate the self-test.

Enter the Service Test Mode as described in *Section 5.3.2.3, Entering the Service Test Mode.*

```
01 VERSION #
02 CLEAR EXT RAM
03 CLEAR ERR LOG
USE * FOR MORE
```

Press [0] [2] to select CLEAR EXT RAM.

```
CLEARING EXT RAM
ADDRESS:   ####
PLEASE WAIT
```

The pump clears the external RAM chip. As the test proceeds, the address changes.

No user response required; pump automatically advances. If using the PVT Form, record the result or "fail" if the procedure fails to complete successfully. Otherwise, proceed to the next step.

```
01 VERSION #
02 CLEAR EXT RAM
03 CLEAR ERR LOG
USE * FOR MORE
```

Press [0] [3] to select CLEAR ERR LOG.

```
CLEARING
  ERROR LOGS
ADDRESS:   ####
PLEASE WAIT
```

The pump clears the error logs. As the test proceeds, the address changes.

No user response required; pump automatically advances. If using the PVT Form, record the results.

Turn off the pump. Wait at least five seconds, then turn the pump on.

```
UNIT SELF-TEST
  IN PROGRESS
TIME IS ##:## XM
      DDD, MMM DD, YY
```

If the pump successfully completes the self-test sequence, the pump is ready for use.

```
1 TPN
2 PAIN MANAGEMNT
3 INTERMITTENT
USE ↓ FOR MORE
```

When the pump displays the first programming screen, turn off the pump and remove the batteries and/or disconnect the power supply from the pump.

5.3.8

PVT Data Form

☐ AIM List 13038-04	☐ AIM Plus List 13967-04	Serial No.:	
--	---	-------------	--

Performance Verification Test	Value	Pass	Fail	N/A
Electrical Test				
Set Clock				
Software Version Verification Main/Safety				
Supply Check EXT AC (7.60 - 8.40V)	V			
REG 5V (4.80 - 5.20V)	V			
Display Test				
Contrast Adjust				
LED Test				
Keypad Test				
Battery Check				
Display Test ALK (4.60 - 5.16V)	V			
LITH (2.79 - 3.50V)	V			
Idle Current DMM (30 mA or less)	mA			
Optics Check I AIR (231 - 255)				
OCCL (231 - 255)				
Optics Check II AIR (14 to 40)				
OCCL (12 to 40)				
Clearing Memory				
Beeper Test Duty Cycle (approx. 50%)	%			
Frequency (AIM 4 kHz, AIM Plus 2.00 - 2.30 kHz)	kHz			
Motor Test Dry Test or Wet Test (circle one)				
DMM (210 mA or less)	mA			
I (115 or less)				
RPM (76.0 - 97.0)				
Servo Calibration Dry Test or Wet Test (circle one)				
MD (50 - 75)				
LR (>25)				
Dry Test: ILO (200 - 450)				
Wet Test: ILO (100 - 450)				
Dry Test: IHI (275 - 600)				

Performance Verification Test	Value	Pass	Fail	N/A
Wet Test: IHI (175 - 600)				
SLOPE (3109 - 4505)				
INTRC (4866 - 5806)				
ERR (0 - 1)				
Encoder Test Dry Test or Wet Test (circle one)				
RATE (396.0 - 404.0 mL)	mL			
TIME (178 - 182 sec)	sec			
Dry Test: Turns Counter Reading (19.8 - 20.2 mL)	mL			
Wet Test: Delivered Volume (19.8 - 20.2 mL)	mL			
Print Test Results (attach printout)				
Printer Test (attach printout)				
Delivery Test Dry Test or Wet Test (circle one)				
Dry Test: Turns Counter Reading (9.95 to 10.05 mL)	mL			
Wet Test: Delivered Volume (19.0 to 21.0 mL)	mL			
Optics Test				
Occlusion Test				
Air-Detection Test				
Current Supply Test				
Current reading DMM (75 mA or less)	mA			
Burn-In Test				
Delivery completes Infused (9600 mL)	mL			
Preparation for Use				
Ext. RAM and logs cleared; self-test completes				

Performed by: _____ Date: _____

Comments:

Section 6

Troubleshooting

This section contains technical information on alert and alarm messages and troubleshooting.

6.1

Technical Assistance

For technical service assistance, to order replacement parts, or to return a pump for service from within the U.S.A., call:

1-800-338-7867

Send product returns from within the U.S.A. to the following location (please call the number above to receive PER registration number before shipping the pump):

**Abbott AIS Technical Service
15330 Avenue of Science, Suite 100
San Diego, CA 92128**

From outside the U.S.A., contact the nearest Abbott Laboratories representative for assistance.

6.2

Setting February 29 on Leap Years

During normal operation, all Abbott AIM and AIM Plus infusion devices will automatically rollover to February 29 on leap year. However, on February 29, the pumps do not allow direct settings for the date or time.

All Abbott AIM and AIM Plus infusion devices are shipped with the correct date. The date will continue to be accurate through the year 1999 and onward, including leap years.

Refer to the Abbott AIM and AIM Plus System Operating Manuals for additional information.

To set the date to February 29 on leap year, proceed as follows:

1. Using the method described in the System Operating Manual, set the time to 11:59 PM, 2/28/00 (or 2/28/04, 2/28/08, etc.).
2. Wait one or two minutes.

3. Cycle the power off and on and verify the date is February 29 on the self-test display.

Note: The time cannot be set when the pump displays February 29. If the correct time takes precedence over the correct date, refer to the following procedure.

To set the correct time when the infused date displayed is February 29, proceed as follows:

1. Set the date to February 28 or March 1.
2. Set the correct time.
3. On March 1, reset the correct time and date.

6.3

Troubleshooting Tables

The following tables are provided to assist in troubleshooting problems with the pump. If problems require component or assembly replacement, refer to *Section 7, Replaceable Parts and Repairs*. Also refer to the PVT in *Section 5, Maintenance and Service Tests* to aid in troubleshooting the pump.

6.3.1

Alert Messages

Following are descriptions and remedies of alert messages. Press the [HELP] key for information about an alert message. As necessary, use the arrow keys to scroll through the message. Press the [BACK-UP] key to exit the help screen.

Table 6-1. AIM/AIM Plus Alert Messages

Message	Condition	Remedy
PROGRAMMING INCOMPLETE	Programming is not complete and no keys have been pressed for more than three minutes.	Press any key to clear.
START	Programmed pump has remained in the stop mode for more than three minutes.	Press [SILENCE] to mute for three minutes. Press [START] to begin protocol or move ON/OFF switch to OFF position to turn pump off.
CHECK PRINTER	Pump to printer connection has been disrupted or print function has been selected without the printer connected.	Press [SILENCE] key to mute for two minutes. Check printer cable connections to pump and printer. Check printer for malfunctions according to manufacturer's recommendations.
ALMOST EMPTY	Delivery will complete in 30 minutes or less. For bolus only program, delivery will complete during next bolus delivery.	Press [SILENCE] to mute for ten minutes. Note: This alert does not occur with TPN, Intermittent, or Variable Time protocols.
EMPTY CONTAINER	Pump has delivered container size programmed. If bolus delivery is in progress when alarm occurs, bolus delivery can be completed or deleted as desired after New Container is chosen.	Press [SILENCE] to mute for two minutes. Press [STOP]. Use New Container function to repeat current program; refer to the <i>System Operating Manual</i> for instructions.
END OF INFUSION	For TPN protocols: Pump has delivered TPN volume or completed auto taper down. For Intermittent protocols: Pump has reached end of off cycle of last dose delivered.	Press [SILENCE] to mute for two minutes (periodic beeping during KVO delivery cannot be muted). Press [STOP] to place pump in stop mode.

6.3.2

Alarm Codes

Following are descriptions, causes, and remedies of alarm conditions. Press the [HELP] key for information about a current alarm condition. As necessary, use the arrow keys to scroll through the message. Press the [BACK-UP] key to exit the help screen.

Before servicing the pump, attempt noninvasive recovery steps. If the alarm is not cleared, repair the pump as needed, and perform the PVT before returning the pump to use (refer to *Section 5.3, Performance Verification Test*).

The alarm log and pump software versions can be reviewed and printed through the Alarm Log feature of the Options Menu (refer to the *System Operating Manual* for instructions).

Note: Error code 999 is displayed if multiple errors occur in one minute.

ERROR DETECTED 999-HIGH ERR CNT CONTACT CUSTOMER SUPPORT

Use the alarm log to itemize error numbers and refer to the following alarm code tables for troubleshooting information.

WARNING:

Always disconnect the pump from the patient before servicing the pump.

6.3.2.1

Function Alarms 001-007

Table 6-2. AIM/AIM Plus Alarm Codes 001 - 007			
Code and Message		Cause	Solution
001	AIR IN LINE or 2 mL AIR DETECTED	Air has been detected in line.	Press [SILENCE] to mute for one minute. Press [STOP]. Disconnect patient from set and follow appropriate prime procedure. Note: Priming not available in Full Lock. If alarm will not clear, refer to <i>page 6-19, #9 in Table 6-5. Troubleshooting.</i>
002	CHECK CARTRIDGE	Cartridge is not installed or improperly installed when the START key was pressed.	Press [SILENCE] to mute for one minute. Check that latch is closed. Check cartridge installation: close slide clamp, remove cartridge, realign dot in red circle on cartridge, and reinsert cartridge in pump. If alarm will not clear, refer to <i>page 6-18, #7 in Table 6-5. Troubleshooting.</i>
003	OCCLUSION	Blockage in the line between pump and patient, or cartridge is improperly installed.	Press [SILENCE] to mute for one minute. Press [STOP]. Check that latch is closed. Check for occlusion and correct problem. Check cartridge installation: close slide clamp, remove cartridge, realign dot in red circle on cartridge, and reinsert cartridge in pump. If alarm will not clear, refer to <i>page 6-18, #7 in Table 6-5. Troubleshooting.</i>
004	PRIME OVERUSE	Operator has primed the pump for more than two minutes.	Press [SILENCE] to clear.
005	USING BATTERIES	Pump was powered by AC adapter, but is now using battery power.	Press [START], [STOP], or [SILENCE] to clear. Check for secure AC connection and restore AC power as necessary.
006	LOW BATTERIES	Pump is powered by batteries and battery voltage is now below 4.0 volts.	Press [STOP], then power off. Replace batteries, or connect pump to AC power, then power on.
007	POWER LOSS	AC adapter was disconnected, batteries were removed, or batteries are dead.	Power off to mute. Replace batteries, or connect pump to AC power.

6.3.2.2

Hardware and Software Alarms 008-143

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143		
Code	Cause	Troubleshooting (repair as required)
008-MOTOR SPEED	Motor speed off by more than 20%.	Change the cartridge, then press [START]. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check for the following: If encoder pulses strobe too slow or are missing, check encoder interface circuit, U7, U8, U31, etc., or motor. If motor voltage or current reading to CPU is incorrect, check for motor voltage, R58, R73, etc., and current readings, U23B, etc.
009-NOT PUMPING	No encoder signals when running.	First, check to see if motor shaft is turning. If the shaft is not turning: Change cartridge, then press [START]. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check motor drive circuit at J11, pin 1 for voltage. If no voltage, repair circuit. If voltage is present at J11 pin 1, check motor. If the shaft is turning: Check for encoder pulses out of motor. If encoder pulses are missing, check motor. Encoder pulses are at J11 pin 7 and 6. They are labeled phase 1 and phase 2. If receiving encoder pulses from motor, check encoder interface circuit, U7, U8, U31, etc.
010-NO OFF CYCLE	Motor still on at start of next cycle.	Change cartridge, then press [START]. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check for U34B shorted drain to source. If motor speed is too slow, check motor.

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143

Code	Cause	Troubleshooting (repair as required)
011-HIGH CURRENT	Excessive motor current while running.	Change cartridge, then press [START]. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check for motor gearbox binding. If binding, replace motor. Check motor current measuring circuit. Check motor.
012-NOT PRIMING	No encoder signals while priming.	Refer to code 009.
013-HIGH CURRENT	Excessive motor current while priming.	Refer to code 011.
014-SPEED CALC.	Motor speed - voltage/current error.	Change cartridge, then press [START]. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check for incorrect motor voltage, R58, R73, etc., or current reading to CPU, U23B, etc. Check motor.
015-NO SPEED CK	MSV calculations not done in 10 seconds.	Press [START]. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check for defective CPU U19.
016-BACK-UP LOW	Lithium battery is low.	Fluid spill may have shorted out lithium battery. This alarm occurs when the pump is in danger of losing memory in external RAM, which could cause multiple errors and additional alarms. Change lithium battery BT2.

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143

Code	Cause	Troubleshooting (repair as required)
100-STUCK KEY	Stuck key detected. May be numeric keypad, function keypad, bolus key, or bolus jack.	Fluid spill may have shorted out the keypad. Power off. Press each key (numeric, function, and bolus) two to three times to loosen. Remove external bolus if attached. Power on again to see if alarm clears. If alarm clears, continue to monitor the pump closely to verify no keypad damage has occurred. If alarm reoccurs, check for defective or damaged keypad or keypad interface as follows: Unplug each keypad ribbon individually to isolate keypad (for external bolus, unplug P1), then power on. If alarm clears, last disconnected keypad is defective. If alarm occurs with all keypads disconnected, check keypad circuit.
101-RTI OVERLAP	RTI did not complete before next RTI.	Occurrence of codes 101 - 106 does not usually indicate a serious problem. Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared. If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i>. Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared. For Codes 101, 102, 103, and 106: If alarm reoccurs, check E clock frequency, problem may be crystal Y1. For Code 102: If alarm reoccurs, check timer U20 or crystal Y2. For Codes 101 - 106: If alarm reoccurs, check CPU U19. For Codes 104 and 105: If alarm reoccurs, check motor encoder or circuit.
102-IRQ OVERLAP	IR1Q did not complete before next IRQ.	
103-XIRQ OVERLAP	XIRQ did not complete before next XIRQ.	
104-CCW COUNTER	Counter-clockwise encoder interrupt did not complete before next interrupt.	
105-CW COUNTER	Clockwise encoder interrupt did not complete before next interrupt.	
106-TIMER COUNT	Timer overflow interrupt did not complete before next interrupt.	

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143

Code	Cause	Troubleshooting (repair as required)
107-AC POWER	AC adapter supplying more than 9.0 volts.	Power off the pump. Verify use of manufacturer's recommended AC power supply. Use a multimeter to verify power supply voltage. Replace power supply as required. Power on again with correct power supply or batteries only.
108-MAIN ROM CKS	Main microprocessor 6811 - ROM checksum error.	Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared.
109-MAIN RAM TST	Main microprocessor 6811 - RAM error.	If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i> . Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared.
110-MAIN STACK	Main microprocessor 6811 - stack overflow.	If alarm reoccurs, check CPU U19. For code 108, check EPROM U15.
111-MAIN CPU TST	Main microprocessor 6811 - background CPU test failed.	Replace the CPU U19.
112-NO MOTOR CTL	Motor power up test failure.	Check motor or motor drive circuit, encoder or encoder interface circuit.
113-NO RAM TEST	RAM check did not complete.	Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared. If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i> . Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check CPU U19 or RAM U14.

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143

Code	Cause	Troubleshooting (repair as required)
114-PROGRAM CRC	CRC error in program. Usually indicates that program was changed but CRC was not updated.	Power off, wait one minute, then power on again to clear alarm, then reprogram the pump. If alarm does not reoccur, it has been cleared. If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i> . Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared.
115-RUN TIME CRC	CRC error in run time parameters. This alarm may occur in conjunction with 143-HRDWRE RESET.	If alarm reoccurs, check CPU U19, RAM U14, or EPROM U15.
116-SPD PROT CRC	CRC error in protocol.	
117-CLR TIME CRC	CRC error -cleared times.	
118-MOTOR ON ERR	Motor turning when it should be off.	Alarm 118 may be caused by the user moving the motor shaft when the pump is in the stop mode, e.g., when changing the cartridge. Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check motor, U34B, U25A, U28 or U24.
119-MOT VOLT ERR	Voltage present on motor when it should be off.	
120-NVRAM WR ERR	Error writing to internal NVRAM.	Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared.
121-BAD CRC TYPE	Invalid type in RAM_CRC.	If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i> . Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared. If the alarm reoccurs, replace the CPU U19.
122-STATE ERR	Invalid main state value.	
123-NO BACK-UP	Lithium backup battery is dead.	Check for fluid spillage on or around lithium battery. The pump may lose memory in external RAM, which could cause multiple errors and additional alarms. Measure lithium battery BT2 with multimeter as soon as possible. If below specification, replace as required. If BT2 is within specification, check battery test circuit or check U21 and its load circuitry.

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143

Code	Cause	Troubleshooting (repair as required)
124-RAM ERR LOG	AIM: Log queue is full. AIM Plus: RAM error log checksum error.	Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared. If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i>. Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared. If alarm reoccurs, replace CPU U19. Also check RAM U14.
125-MOT NOT CAL	Motor not calibrated.	Motor calibration procedure not performed during PVT Electrical Test, NVRAM has been cleared without recalibrating the motor, or lithium battery BT2 has failed. Use the software diagnostics to check lithium battery voltage. If voltage is within specification, recalibrate motor as follows: Power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i>. Select 20 SERVO CAL DGN. Complete the calibration as described in <i>Section 5.3.2.19, Servo Calibration</i>. Power off, wait one minute, then power on again.
126-TIME BASE	Oscillator and real time clock don't agree.	Check timer U20, crystal Y2, CPU U19, or crystal Y1.
127-SFTY SW VER#	Safety microprocessor 6805 - version number not what expected.	May be caused by a temporary timing problem in the communication between the two processors. Power off, wait one minute, then power on to reset the communication interface. If the alarm reoccurs, check for incorrect or defective EPROM U15 or safety CPU U18.

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143

Code	Cause	Troubleshooting (repair as required)
128-SFTY ROM CRC	Safety microprocessor 6805 - ROM checksum error.	Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared.
129-SFTY RAM TST	Safety microprocessor 6805 - RAM integrity error.	If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i> . Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared.
130-SAFETY STACK	Safety microprocessor 6805 - stack overflow.	If any of these alarms occur twice, check safety CPU U18.
131-SFTY CPU TST	Safety microprocessor 6805 - background CPU test failed.	Replace CPU U18.
132-SFTY MOT ON	Safety microprocessor 6805 - motor turning when it should be off.	May be caused by the user moving the motor shaft when the pump is in the stop mode, e.g., when changing the cartridge. Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check motor or motor drive circuit, encoder or encoder interface circuit, or safety CPU U18.
133-SFTY MOT OFF	Safety microprocessor 6805 - no encoder signals when motor should be on.	Power off, change cartridge, wait one minute, then power on. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check motor or motor drive circuit, encoder, encoder interface circuit, or safety CPU U18.
134-SFTY MOT SPD	Safety microprocessor 6805 - motor speed is off by more than 20%.	Power off, change cartridge, then power on. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check encoder in motor or encoder interface circuit. More remote possibilities are main CPU U19 or safety CPU U18.

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143

Code	Cause	Troubleshooting (repair as required)
135-SPI CHECKSUM	SPI packet checksum error.	May be caused by a temporary timing problem in the communication between the two processors. Power off, wait one minute, then power on to reset the communication interface.
136-SPI ASCII	SPI packet not ASCII.	
137-SPI TRANSFER	SPI packet transfer error.	If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i> . Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared. If the alarm reoccurs, check main CPU U19 or safety CPU U18.
138-SPI WAITING	SPI packet wait state error.	
139-SPI PROCESS	SPI packet processing error.	
140-SPI ENDTRANS	SPI packet EOT error.	
141-SPI POST ERR	SPI packet power on error.	Return the pump to the manufacturer to have the processor properly configured or replace the main CPU U19.
142-CONFIG REG	CONFIG register error which indicates that the processor is not properly configured.	

Table 6-3. AIM/AIM Plus Alarm Codes 008 - 143

Code	Cause	Troubleshooting (repair as required)
143-HRDWRE RESET	Hardware reset. Pump did not go through the power loss code.	If the power is turned off or lost after the pump has been on for only a short time the supercap may not fully charge, and therefore the pump is unable to complete its processing. Weak batteries may make the supercap charging take longer, thus increasing the chances of this alarm occurring. Check the voltage of the batteries and change both batteries if required. Power off, wait one minute, then power on again to clear alarm. If alarm does not reoccur, it has been cleared. If alarm reoccurs, power off the pump and access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i>. Select 02 CLEAR EXT RAM then 03 CLEAR ERR LOG. Power off, wait one minute, then power on again. If alarm does not reoccur, it has been cleared. If alarm reoccurs, check address or data pins on CPU U19 or EPROM U15 or other failures which would cause the supervisory circuit to reset the main microprocessor. Also check C53.

6.3.3**Servo Calibration Failure Codes**

When unable to complete the motor servo calibration, the pump may display a failure code. Refer to *Table 6-5. Troubleshooting*, for possible error sources and solutions.

Table 6-4. Servo Calibration Failure Codes

Code	Reason for Failure
1	The minimum duty cycle required is over 60 (on a 0-255 scale).
2	The pump is detecting encoder signals when the pump should be off.
3	Less than ten encoder signals were detected when the duty cycle was greater than 60.
4	The motor current is zero.
5	The motor delivers less than 450 mL/hr when the duty cycle is 250.

6.3.4

Troubleshooting Problems and Solutions

The following table lists a selection of possible functional problems that may occur with the pump. Attempt any noninvasive solutions before repairing the pump.

Table 6-5. Troubleshooting		
Symptoms	Possible Source	Troubleshooting (repair as required)
1. No pump display when pump is switched to ON. or Display scrambled and beeper pattern is not normal.	Blown fuse F1.	Check for blown fuse F1; replace F1.
	5.0V or 3.3V supply voltage low.	Check supply current for evidence of excessive load caused by possible trace shorts or bad IC's. Check U3, U6 or shorted 5V or 3.3V bypass capacitors.
	Crystal Y1.	Check for presence of E clock; if no E clock; replace crystal.
	Microprocessor U19.	Check for presence of E clock; replace CPU U19.
	EPROM U15.	Check for bad contacts on U15 or associated socket; replace U15.
	Solder joints on U14 or U14.	Check soldering. Resolder joints or replace U14.
2. No display or scrambled display on power-up, but beeper pattern appears normal.	Bad timer circuit causes continuous timer interrupt.	Check socket connections, replace U19 as required.
	Defective address decoding.	Check outputs U12-6, U17-13.
	No reset or continuous reset.	Check U21 and associated components.
	Display interface U32.	Check outputs at display connector. Make certain display V_{DD} is at least 4.9V.
	Display, display connector, or flex cable.	Replace display or connector as required.
	Contrast circuit U2A, U9B, U11B, Q3, etc.	Contrast level at V_o must be close to zero volts for full contrast.
	Bad solder joints on U14 or defective U14.	Check soldering. Resolder joints or replace U14.

Table 6-5. Troubleshooting

Symptoms	Possible Source	Troubleshooting (repair as required)
3. One or more keys on keypad inoperative.	Locked keypad.	Unlock keypad.
	Keypad ribbon cable.	Check that keypad ribbon cable is plugged in properly to circuit board.
	Keypad.	Typical keypad failure causes one entire row or column to be inoperative. Replace keypad.
	Keypad interface.	Check connector J3 and J14, and U18. Check for keypad column strobes at PBX0, PBX1, etc.
4. Motor won't turn or turns at incorrect speed.	U11A.	Check for output DC voltage change at U11-1 as PWM duty cycle is changed at U2E pin 11.
	Current amplifier U23B and/or associated components.	No voltage or too low a voltage at U23-7 output causes too slow a motor speed; replace components as necessary.
	U24.	Verify that U24-6 pulses whenever U24-7 is less than 1.3V (approximately).
	U28 or U27A.	Both should be on when U24-6 is high
	Summing amplifier U23A.	Verify that amplifier operates properly; replace as necessary.
	Comparator U25B.	U25B-7 should be high when U24-6 is high.
	Transistor U13B.	U13B should be off when U13-4 is high.
	Transistor U34B.	U34-5 should be on when its gate drive is low; replace as necessary.
	Comparator U25A.	U25-1 should pulse low when U24-6 pulses high.
	Voltage converter U22 or associated components.	U22-5 should be -5V when motor drive circuit is on.
	Transistor U27B.	U27-5 should be low when U27-4 is high.
	Motor.	Replace motor.

Table 6-5. Troubleshooting

Symptoms	Possible Source	Troubleshooting (repair as required)
5. Tachometer produces incorrect RPM or no pulses	U7, U8, U31 or associated components.	Replace components as necessary.
	Motor tachometer.	Check both phase1 and phase2 outputs approx. 90° out of phase. Replace motor as required.
	Connections from board to motor.	Repair connections as required.
	No encoder power.	Check U10C or Q4.
	No encoder strobe.	Check for strobe pulse.
6. OCCLUSION or CHECK CARTRIDGE display does not appear when occlusion is present	Q11 shorted collector to emitter causing LED drive to be too high.	Replace Q11.
	Open R60.	Replace R60.
	Occlusion phototransistor or wiring.	Repair wiring or replace entire optics assembly.
	A/D, or A/D reference.	Replace U19.

Table 6-5. Troubleshooting

Symptoms	Possible Source	Troubleshooting (repair as required)
7. OCCLUSION alarm or CHECK CARTRIDGE alarm stays on.	Cartridge may not be fully installed.	Check to assure cartridge is firmly seated in motor frame and that latch is fully closed and flush with back case.
	No cartridge installed or cartridge may be defective.	Install new cartridge.
	Dirty optics.	Clean optics surfaces as directed in <i>Section 5, Maintenance and Service Tests</i> . Replace optics assembly as required.
	Loose latch.	Check for loose screws on latch assembly. Replace ejector pivot pins, spring, or latch assembly as required.
	Optics or associated components.	Check LED drive pulse for proper level. If drive is low or off, check U9C, Q9, D19, D20 and Q11. Check pulse for low levels (less than 2.5V) at collectors of phototransistors when cartridge is in place and no occlusion is present. Check A/D for proper operation. Replace optics assembly as required.
	A/D of CPU.	Replace U19.
8. AIR-IN-LINE alarm does not come on when air is present in sensing chamber of tubing.	A/D reference from CPU.	Check R115, C43 and 3.3V supply.
	Air sensitivity alarm may be disarmed.	Place pump in stopped mode and check air sensitivity setting. Revise as necessary (refer to <i>System Operating Manual</i> for instructions).
	Dirty optics.	Clean optics surfaces as directed in <i>Section 5.1, Cleaning the Pump</i> .
	Cartridge may not fit properly into motor frame assembly or may not be completely latched.	Correct fit. Replace cartridge as necessary. Replace latch assembly as required.
	Optics or associated components.	Replace interface components or replace optics assembly as required.
	A/D input at microprocessor.	Check in optics check test mode. Replace U19 as required.
	LED drive component.	Check and replace as required.

Table 6-5. Troubleshooting

Symptoms	Possible Source	Troubleshooting (repair as required)
9. AIR-IN-LINE alarm stays on even when air is not present in sensing chamber of cartridge.	[PURGE] key may not have been pressed to clear alarm.	Press [PURGE] (refer to the <i>System Operating Manual</i> for instructions).
	Q11 shorted collector to emitter causing LED drive to be too high.	Replace Q11.
	R59 shorted.	Replace R59.
	Air phototransistor or wiring.	Repair wiring or replace optics assembly.
	Microprocessor.	Replace U19.
10. Timer does not keep time.	Crystal Y2 or timer chip U20.	Replace Y2 or U20 as required.
	If time is lost when batteries are removed, check BT1.	Replace lithium battery if voltage is less than 2.85V.
11. Beeper inoperative, but display appears normal.	Audio transducer, Q7, U26A, U26B, U26C, U10F, U35A U35B or U11C.	Trace signal from PW3 to J12. Replace components as required.

Table 6-5. Troubleshooting

Symptoms	Possible Source	Troubleshooting (repair as required)
12. Short battery life.	Verify battery voltage using a voltmeter.	Replace all four batteries as necessary.
	Rechargeable AA batteries in use.	Rechargeable AA batteries not recommended.
	Motor drive circuit or tantalum capacitors.	Measure supply current and motor current drains to isolate components and replace as necessary. Power off the pump, access the test mode as described in <i>Section 5.3.2.3, Entering the Service Test Mode</i>. Select #08 MOTOR TEST. Complete the test as described in <i>Section 5.3.2.18, Motor Test</i>, and confirm that the readings fall within acceptable ranges. Press [OPTIONS] once to display the averaged motor current and the motor speed in revolutions per minute. Press [OPTIONS] again to display the instantaneous motor current and clear the motor speed. To isolate the motor controls or activate the watchdog, use the following keys: Watchdog: [4] = on, [1] = off 6811 control: [5] = on, [2] = off 6805 control: [6] = on, [3] = off

6.3.5 Port Assignments

Table 6-6. AIM/AIM Plus Port Assignments	
Port #	Description
PA0	Pulses to CPU when motor turns counterclockwise.
PA1	Unused.
PA2	Output from CPU to control encoder power, 1=ON.
PA3	Output from CPU to control display backlight, 0=ON.
PA4	Pulse high from CPU to control optics LED drive, 1=ON.
PA5	Input to CPU from the 6805. 1=6805 has a message for the 6811 CPU.
PA6	Output from CPU to control motor drive, 1=ON.
PA7	Input pulses to CPU when motor turns clockwise.
PD0	Unused.
PD1	Unused.
PD2	Master in, slave out, serial data input to main CPU.
PD3	Master out, slave in, serial data output from main CPU.
PD4	Serial clock from main CPU for SPI bus.
PD5	Unused.
PE0	Analog input to CPU from optical air detector, FS = 3.3 V (minimal light received).
PE1	Analog input to CPU from occlusion detector, FS = 3.3 V (minimal light received).
PE2	Motor current input to CPU, FS = 11 mA.
PE3	Motor voltage input to CPU, FS = 14.8V.
PE4	Alkaline (or NiMH) battery voltage to CPU, FS = 6.6V.
PE5	5V Regulator input to CPU, FS = 6.6V.
PE6	Power supply input to CPU, FS = 9.9V.
PE7	Lithium battery voltage, FS = 3.3V.
PG5	Unused.
PG6	Output from CPU to trigger watchdog, should occur at least every 1.0 second to prevent RESET.
PW1	PWM output for motor speed.

Table 6-6. AIM/AIM Plus Port Assignments

Port #	Description
PW2	Tach strobing pulse, period = 50 microsec, low for 10 microsec., high for 40 microsec.
PW3	Beeper drive frequency and duty cycle.
PW4	PWM contrast control for display, minimum duty cycle = maximum contrast.
PAX0	Backup CPU output for audible alarm, 1 = alarm, overrides PWM output from the main CPU.
PAX1	Serial RS-232 control signal output from CPU.
PAX2	Controls power to serial RS-232 interface circuit, 1 = ON.
PAX3	Serial RS-232 control signal input to CPU.
PAX4	Output from backup CPU to turn off motor, 1 = motor off.
PAX5	Output from backup CPU to signal communications is ready.
PAX6	Output from CPU to turn on AA alkaline battery test circuit and apply load to battery, 1 = ON.
PAX7	Battery test circuit control, 1 = ON.
PBX0	Output from CPU for keypad column 0 drive.
PBX1	Output from CPU for keypad column 1 drive.
PBX2	Output from CPU for keypad column 2 drive.
PBX3	Output from CPU for keypad column 3 drive.
PBX4	Output from CPU for keypad column 4 drive.
PBX5	Unused.
PBX6	Output from CPU to control alarm LED, 0 = ON.
PBX7	Unused.
PCX0	Input to CPU for keypad row 0.
PCX1	Input to CPU for keypad row 1.
PCX2	Input to CPU for keypad row 2.
PCX3	Input to CPU for keypad row 3.
PCX4	Input to CPU for keypad row 4.
PCX5	Input to CPU for keypad row 5.
PCX6	Input to CPU for keypad row 6.
PCX7	Unused.

Table 6-6. AIM/AIM Plus Port Assignments

Port #	Description
PDX0	Input to CPU for received RS-232 data.
PCX1	Output from CPU for transmitted RS-232 data.
PDX2	Master in, slave out, serial output from backup CPU.
PDX3	Master out, slave in, serial input to backup CPU.
PDX4	Serial clock input to backup CPU.
PDX5	Slave select = 0, puts backup CPU in slave mode.
PDX7	Indicates power switch has been turned off, 1=OFF.

6.3.6**IC Location Codes**

The following table lists the location of ICs by schematic sheet number and grid section, as indicated by letter and number. The fold-out schematics can be found in *Section 9, Drawings*.

Table 6-7. AIM/AIM Plus IC Location Codes								
IC(U)	Schematic		IC(U)	Schematic		IC(U)	Schematic	
	Sheet	Section		Sheet	Section		Sheet	Section
2A	3	A7	11A	2	C6	26A	2	B3
2B	1	B5	11B	3	B6	26B	2	B3
2C	1	B5	1B	3	B6	26B	2	B3
2D	1	B6	11D	2	B4	26C	2	B3
2E	2	C7	12A	1	B6	27A	2	D3
2F	3	C4	12B	1	B5	27B	2	D2
3	3	D5	12C	1	B5	28	2	D4
4	3	B3	12D	1	B5	30A	2	B6
6	3	D3	13A	3	B2	30B	2	B6
7A	3	A4	13B	2	D5	30C	2	A6
7B	3	B4	14	1	D4	30D	2	A6
8A	3	B4	15	1	C4	30E	2	A6
8B	3	A4	16	1	B6	30F	2	B8
9A	3	C6	17	1	A6	31A	3	B3
9B	3	B7	18	1	B3	31B	3	A3
9C	2	B6	19	1	C3	32	3	B6
9D	3	C6	20	1	B4	34A	2	A4
9E	2	C6	21	1	D3	34B	2	C5
9F	2	A5	22	2	C4	35A	2	B3
10A	3	C6	23A	2	D5	35B	2	C5
10B	3	A5	23B	2	D6	35C	2	C3

Table 6-7. AIM/AIM Plus IC Location Codes

IC(U)	Schematic		IC(U)	Schematic		IC(U)	Schematic	
	Sheet	Section		Sheet	Section		Sheet	Section
10C	3	A5	24	2	D5	35D	2	C2
10D	2	C6	25A	2	C4			
10E	2	A4	25B	2	C3			
10F	2	B3						

6.4

Software Diagnostic Tests

The Service Test Mode contains a menu of diagnostic tests that can be used by trained technicians and field service personnel to isolate problems.

To use these tests, power off the pump, then access the test mode as described in *Section 5.3.2.3, Entering the Service Test Mode*. After the correct lock sequence number is entered the test menu appears. The arrow keys can be used to scroll through the menu, but an item can be selected at any time by entering the test number. Power off the pump to exit the Service Test Mode.

- 01 VERSION #
- 02 CLEAR EXT RAM
- 03 CLEAR ERR LOG
- 04 CLEAR NVRAM (always recalibrate the motor after clearing NVRAM)
- 05 SET CLOCK
- 06 SUPPLY CHECK
- 07 BATTERY CHECK
- 08 MOTOR TEST
- 09 AIR/OCCL TEST
- 10 KEYPAD CHECK
- 11 DISPLAY TEST
- 12 CONTRAST ADJ
- 13 LED TEST
- 14 TIMER CHECK
- 15 BEEPER TEST
- 16 LOOPBACK TEST
- 17 PRINTER TEST
- 18 PRINT LOGS/NV
- 19 EXT RAM TEST
- 20 SERVO CAL DGN
- 21 ATP TESTS
- 22 PRINT ATP TST
- 23 ENCODER TEST

Section 7

Replaceable Parts and Repairs

This section details removal and replacement procedures for AIM and AIM Plus parts and lists the equipment and materials required to perform the procedures. Always perform the PVT after a replacement procedure.

7.1

Spare Parts Price List

Replaceable parts for the infusion system are itemized in the Spare Parts Price List. To request a copy of the current Spare Parts Price List, contact Abbott Laboratories (see *Section 6.1, Technical Assistance*). For convenient reference, insert a copy of the Spare Parts Price List here.

7.2

Safety Precautions

Before opening the front enclosure of the infusion system, take all necessary precautions for working on high-voltage equipment.

WARNING:

Unless otherwise indicated, disconnect the infusion system from AC power before performing any replacement procedure.

WARNING:

Possible explosion hazard if product is serviced or repaired in the presence of flammable anesthetics.

CAUTION: Use proper ESD grounding techniques when handling components. Wear an antistatic wrist strap and use an ESD-protected workstation. Store the PCB in an antistatic bag before placing it on any surface.

7.3

Pump Disassembly Procedure

Disassemble the pump only to the point required for repair.

Equipment Required:

- ☐ 5/16-inch slotted nut driver
- ☐ 3/16-inch slotted nut driver
- ☐ Phillips screwdriver
- ☐ Blade-type screwdriver

1. Lay the pump face down on a soft surface with the base facing you. Remove the battery door and set aside.
2. Peel the void label off of the screw on the upper-left corner of the back case.
3. Remove all the screws on the back case. Through the hole in the back case created by removing the screw in the upper left corner, remove the smaller screw that connects the motor frame to the front case (refer to *Figure 7-1. Back Case Screws*).

For further repair instructions regarding the back case or its labels, refer to *Section 7.5, Back Case Assembly*.

4. Clean the RTV along the seam of the case as required.

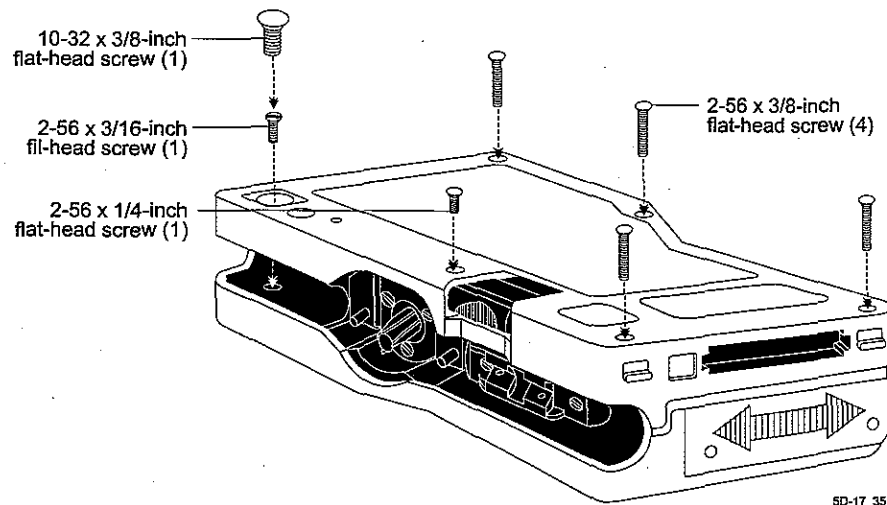
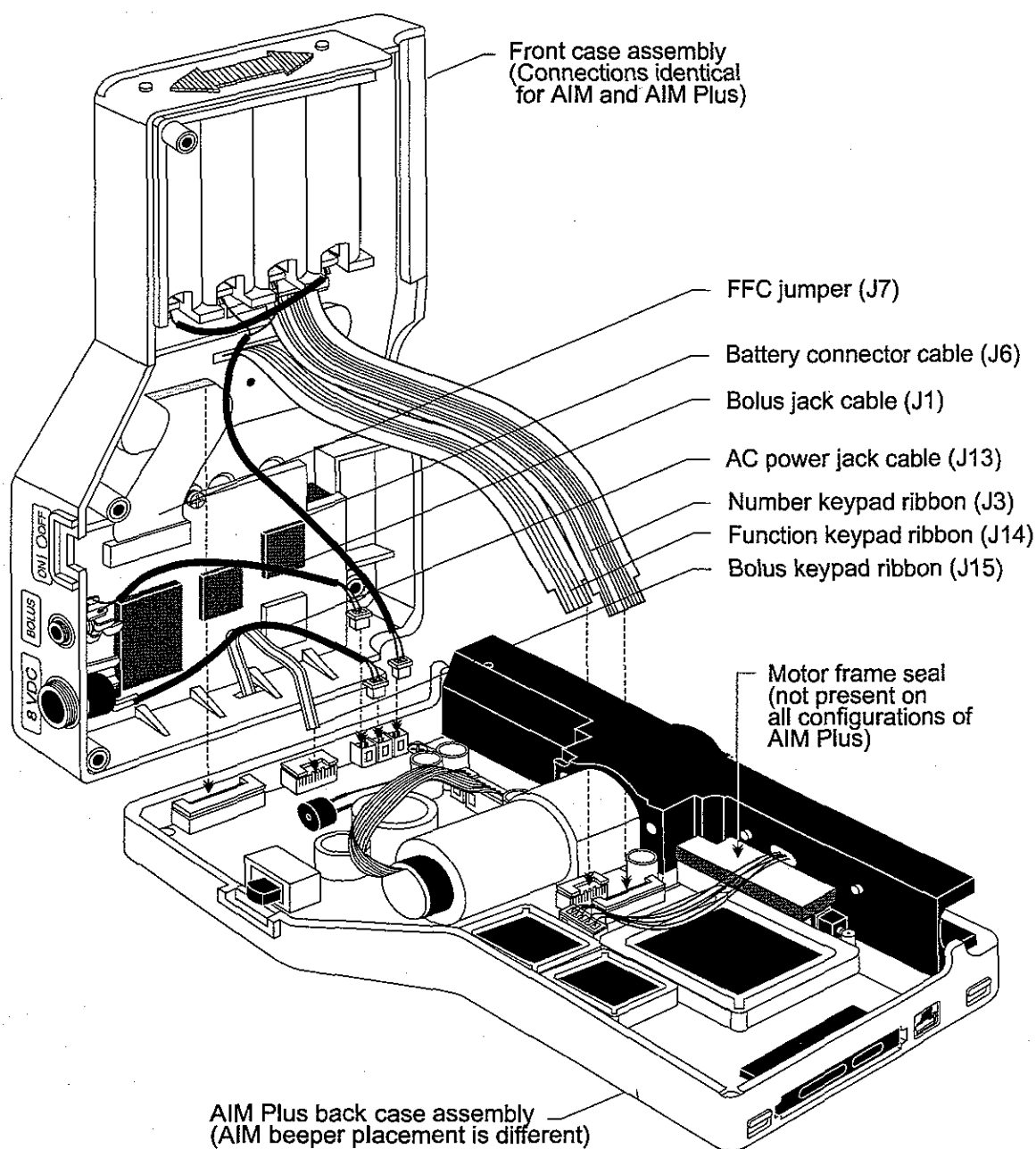


Figure 7-1. Back Case Screws



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Figure 7-2. Front Case Connections

5. Turn the pump over and lift the front case away from the unit.
6. Disconnect the battery connector cable, bolus jack, and AC power jack pins from the circuit board (refer to *Figure 7-2. Front Case Connections*).
7. Disconnect the number, function, and bolus keypads and the display module from the circuit board by pulling up the locking bars and sliding the keypad ribbons and the FFC jumper out of the connectors (refer to *Figure 7-2. Front Case Connections*).
8. Remove the front case and set aside.

For further repair instructions regarding the front case and its components or the display module, refer to *Section 7.10, Front Case Assembly* or *Section 7.11, Display Module*.

Section 7, Replaceable Parts and Repairs

9. Open the latch and lift the motor frame (with motor, optics, and latch assemblies attached) up and out from the front case.
10. Remove motor frame seal as required.
11. Unplug the motor and optics connections from the PCB. For the AIM only, unplug the beeper connection (refer to *Figure 7-3. Motor, Optics, and Beeper Connections*).

For further repair instructions regarding the optics, motor, and latch assemblies, refer to *Section 7.6, Optics Assembly*; *Section 7.7, Motor Assembly*; and *Section 7.8, Latch Assembly*.

For further repair instructions regarding the beeper, refer to *Section 7.5.1, AIM Beeper* or *Section 7.9.1, AIM Plus Beeper*.

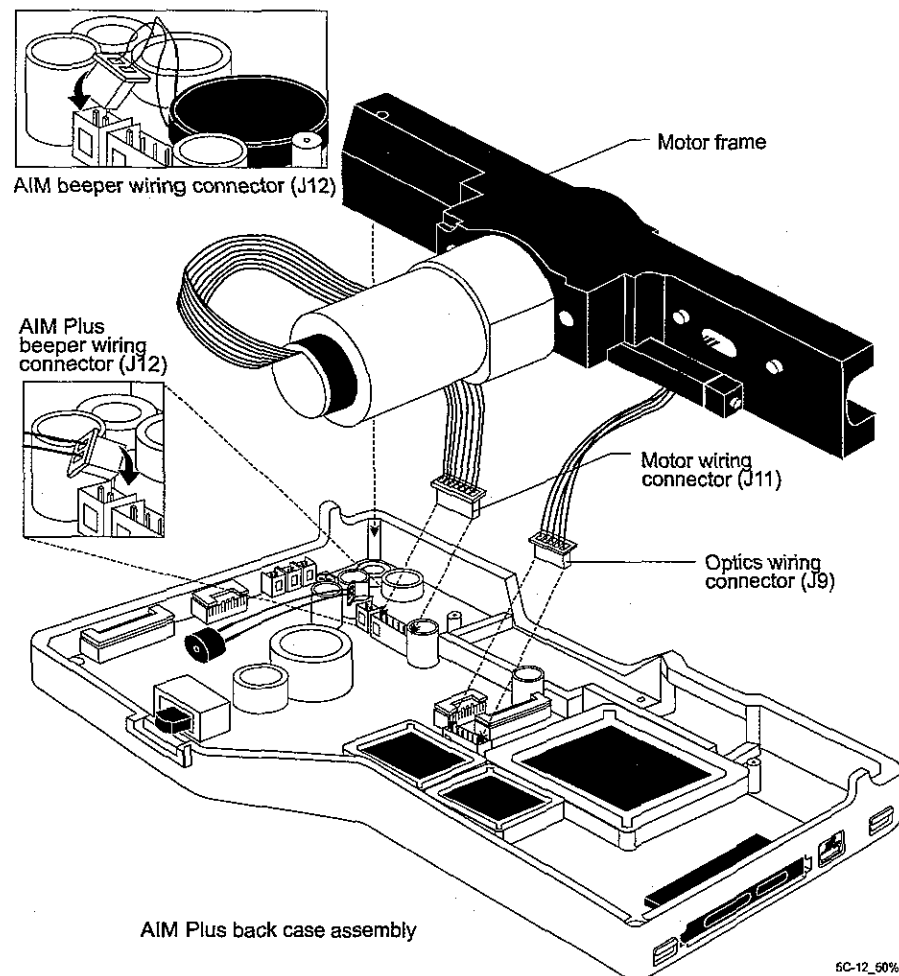


Figure 7-3. Motor, Optics, and Beeper Connections

12. Remove the two screws holding the PCB to the back case (refer to *Figure 7-4. AIM and AIM Plus PCBs to Back Cases*).
13. Gently lift the PCB from the back case.

For further repair instructions regarding the PCB and associated components, refer to *Section 7.9, PCB Assembly*.

For further repair instructions regarding the back case and labels, refer to *Section 7.5, Back Case Assembly*.

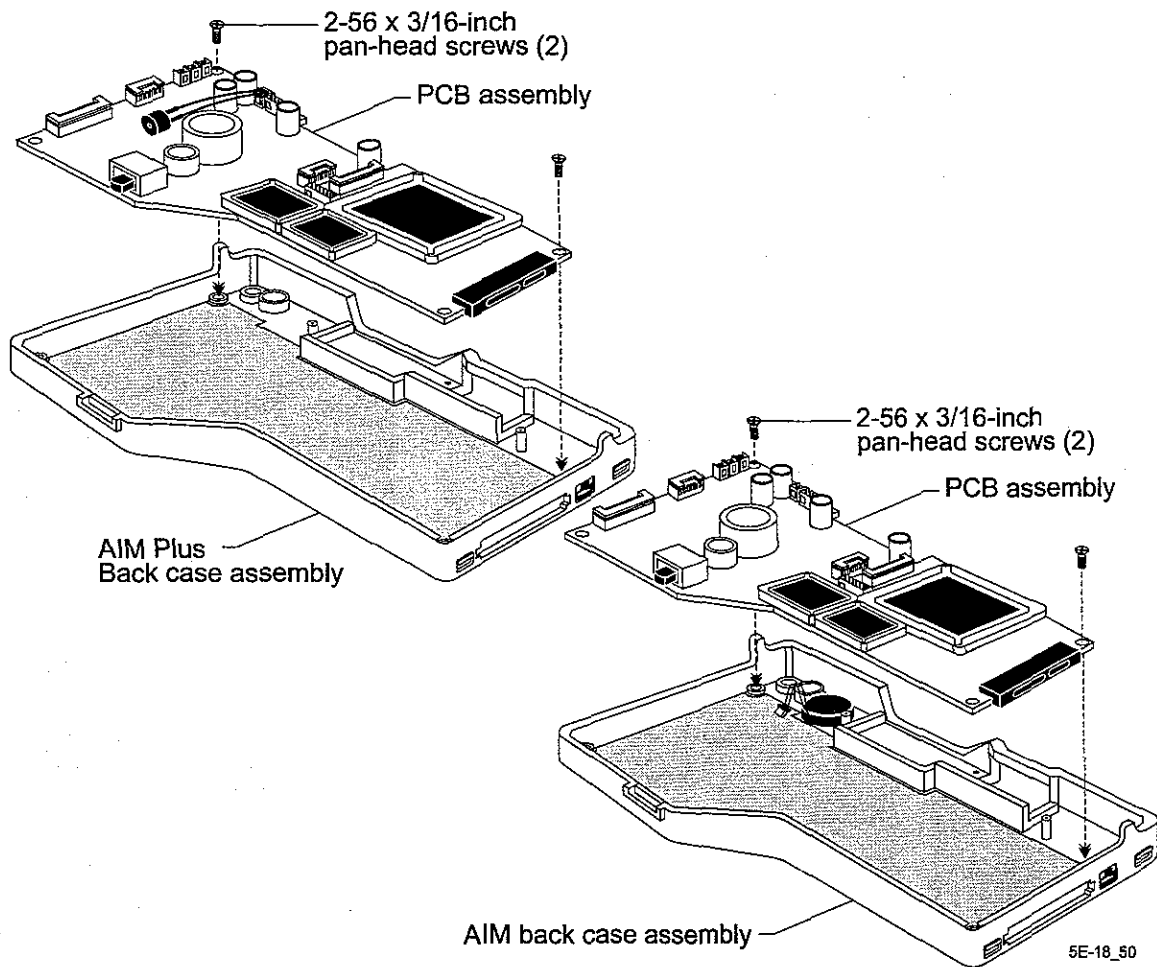


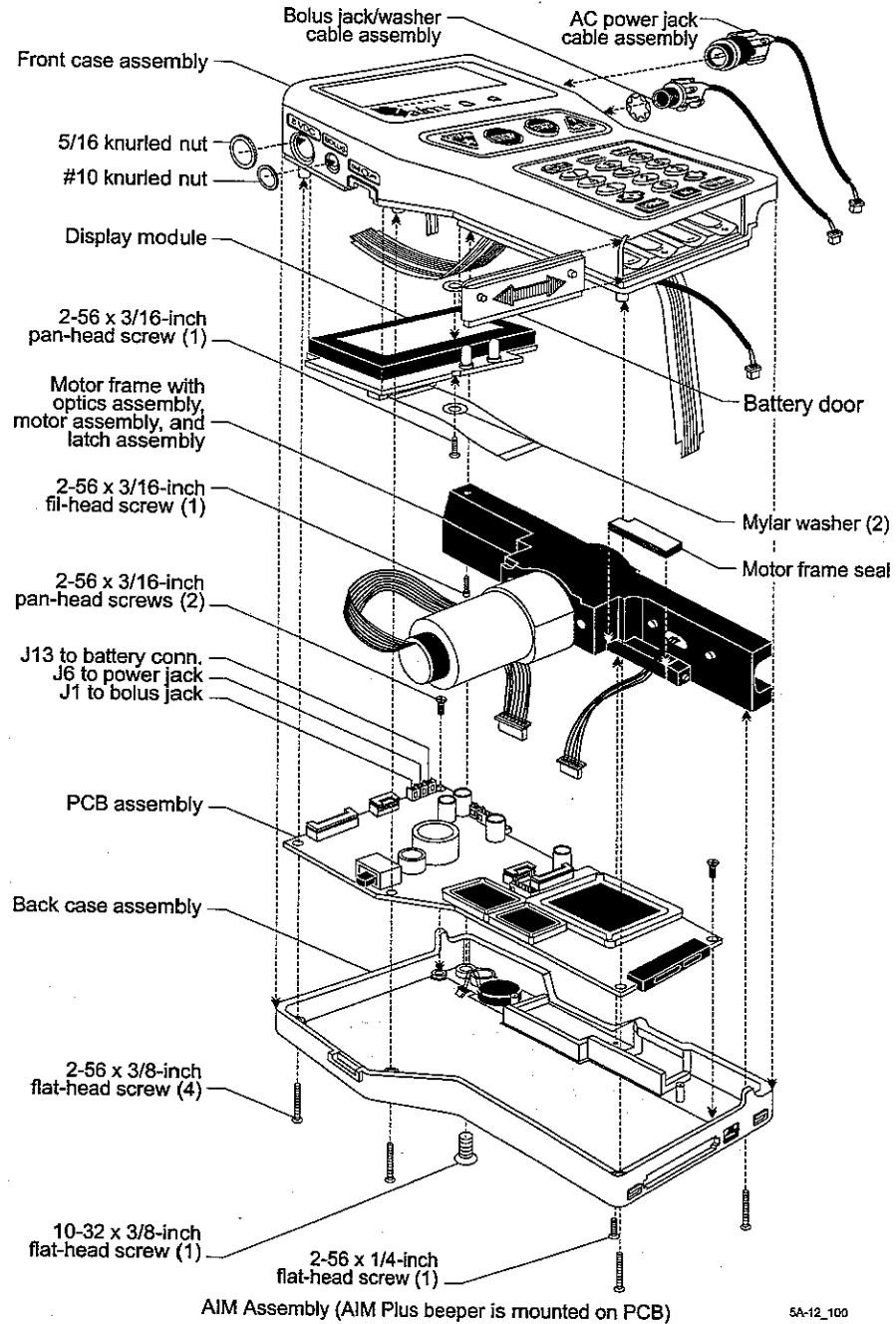
Figure 7-4. AIM and AIM Plus PCBs to Back Cases

7.4

Pump Reassembly Procedure

CAUTION: Any repair or replacement must be followed by the performance verification test (PVT) and burn-in test described in Section 5.

After the necessary repairs have been made, reassemble the pump as follows (refer to *Figure 7-5. Pump Assembly*).



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Figure 7-5. Pump Assembly

The following hardware is available for replacement:

- ☐ 10-32 x 3/8-inch flat-head screw
- ☐ 2-56 x 1/4-inch flat-head screw
- ☐ 2-56 x 3/8-inch flat-head screw
- ☐ 2-56 x 3/16-inch fillister-head screw
- ☐ 2-56 x 3/16-inch pan-head screw

As required, refer to , when making PCB connections.

1. Carefully lay the PCB into the back case.
2. Attach the PCB to the back case using two 2-56 x 3/16-inch pan-head screws (refer to *Figure 7-4. AIM and AIM Plus PCBs to Back Cases*). Tighten screws.
3. Make the following electrical interconnections, then place the motor frame with optics, latch, and motor assemblies in place into the back case (refer to *Figure 7-3. Motor, Optics, and Beeper Connections*).
 - Beeper pin to connector J12 (AIM Plus beeper may already be attached)
 - Motor pin to connector J11
 - Optics pin to connector J9
4. Open the latch and place the motor frame into the back case. Close the latch.
5. Make the electrical interconnections between the front case and the PCB (refer to *Figure 7-2. Front Case Connections*). To install the display module and each keypad, unlock the appropriate connector on the PCB by pulling up the locking bar, insert component end into connector without twisting the ribbon, then lock connector by pushing the bar down.
 - Battery connector cable to connector J6
 - Bolus jack to connector J1
 - AC power jack to connector J13
 - FFC jumper (display module) to connector J7
 - Number keypad to connector J3
 - 4-Button keypad to connector J14
 - Bolus keypad to connector J15
6. Tilt the top case onto the motor frame and back case. Be sure that the motor frame fits within the ledge on the top case and that the keypad cables loop back toward the printer connector. Push down on the top case, then turn the pump over. Verify that none of the wires obstruct the mounting holes.
7. Attach the motor frame to the front case with a 2-56 x 3/16-inch fillister-head screw (refer to *Figure 7-1. Back Case Screws*).
8. Attach the back case to the front case using four 2-56 x 3/8-inch flat-head screws, one 2-56 x 1/4-inch flat-head screw next to the latch, and one 10-32 x 3/8-inch flat-head screw at the top left. Tighten all screws.

7.4.1

Alternate Assembly Instructions for RTV Sealing

1. Lay a bead of RTV approximately 1/8-inch thick along the inside edge of the bottom case at the printer port opening.

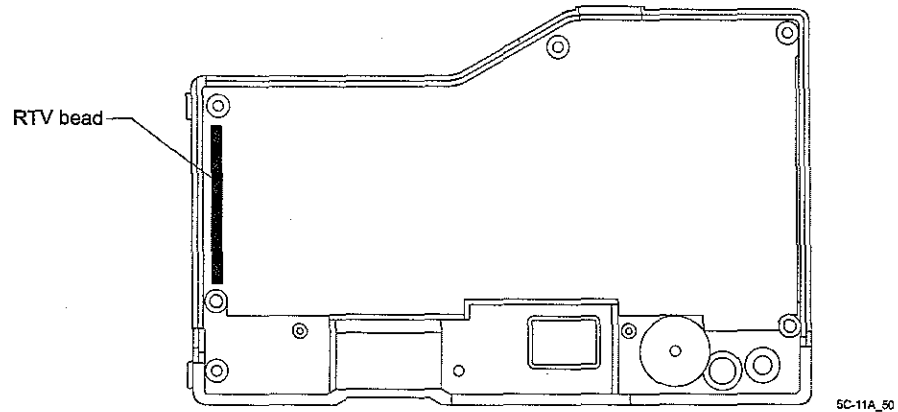


Figure 7-6. RTV Sealing for Printer Port

2. Carefully lay the PCB into the back case.
3. Attach the PCB to the back case using two 2-56 x 3/16-inch pan-head screws (refer to *Figure 7-4 AIM and AIM Plus PCBs to Back Cases*). Tighten Screws.
4. Lay a second bead of RTV across the board at the top of the printer port to seal all gaps. Clean the outside of the printer port of any excess RTV, be sure not to create a gap in the seal.
5. Apply a small 1/16" bead of RTV on the bottom case as shown below.

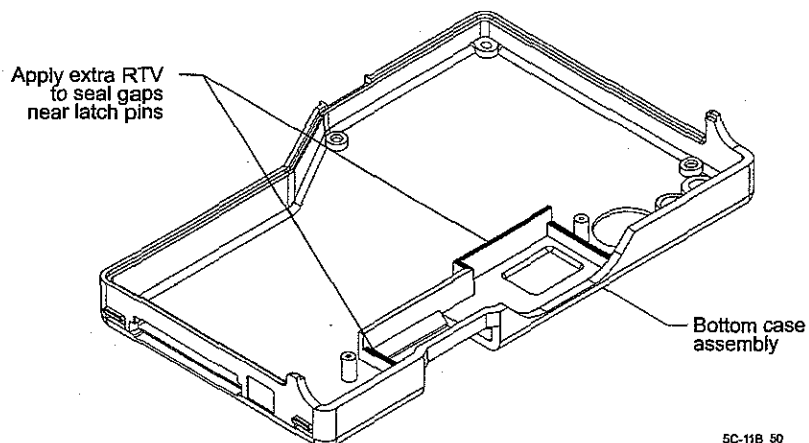
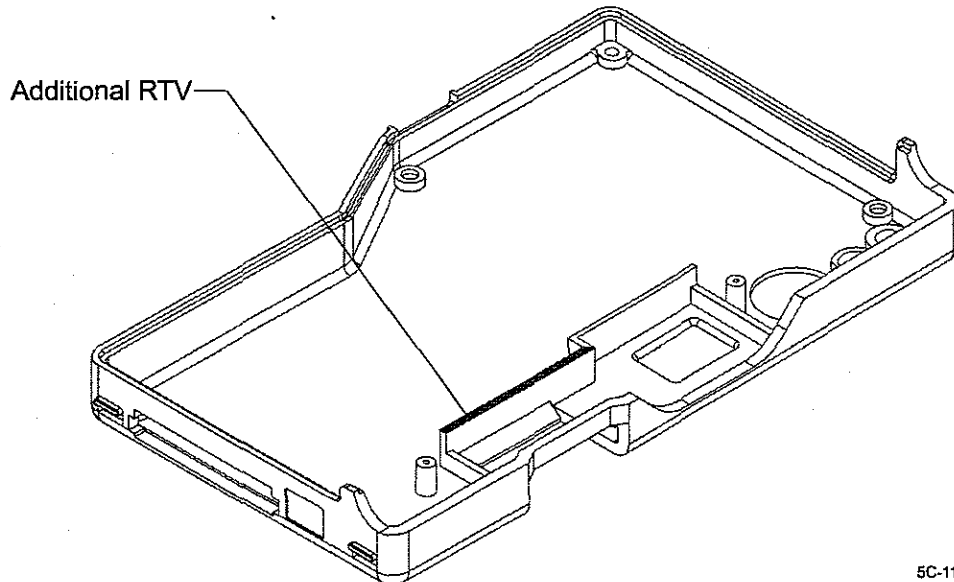


Figure 7-7. RTV Sealing for Side, Bottom Case

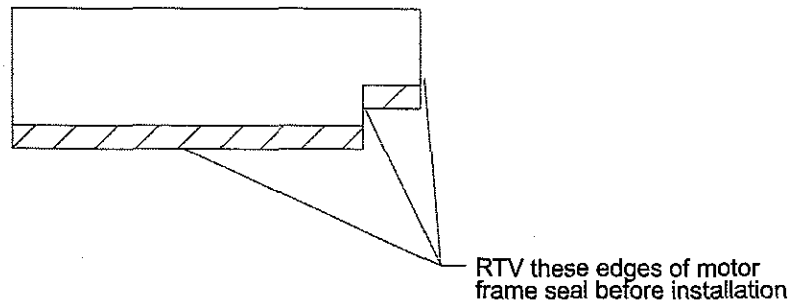
6. Place the motor frame assembly into place on the RTV. Install the 2-56 x 1/4-inch flat-head back case screw near the latch to hold the motor frame in place.
7. RTV the bottom case for the motor frame seal as shown below. (Motor frame not shown for clarity.)



5C-11C_50

Figure 7-8. RTV Sealing for Motor Frame

8. Peel the adhesive backing off the motor frame seal and coat the edges in contact with the motor frame with RTV. Install the seal behind the motor frame as shown in Figure 7-5. Fill the space near the latch pins with RTV. Visually inspect to ensure that there are no voids or gaps in the seal.



5D-21_25

Figure 7-9. Motor Frame Seal

9. Make the following electrical interconnections (refer to *Figure 7-3 Motor, Optics, and Beeper Connections*):
 - Beeper pin to connector J12 (AIM Plus beeper may already be attached)
 - Motor pin to connector J11
 - Optics pin to connector J9
10. Make the electrical interconnections between the front case and the PCB (refer to *Figure 7-2. Front Case Connections*). To install the display module and each keypad, unlock the appropriate connector on the PCB by pulling up the locking bar, insert component end into connector without twisting the ribbon, then lock connector by pushing the bar down.

Section 7, Replaceable Parts and Repairs

- Battery connector cable to connector J6
 - Bolus jack to connector J1
 - AC power jack to connector J13
 - FFC jumper (display module) to connector J7
 - Number keypad to connector J3
 - 4-Button keypad to connector J14
 - Bolus keypad to connector J15
11. Tilt the top case onto the motor frame and back case. Be sure that the motor frame fits within the ledge on the top case and that the keypad cables loop back toward the printer connector. Push down on the top case, then turn the pump over. Verify that none of the wires obstruct the mounting holes.
 12. Attach the motor frame to the front case with a 2-56 x 3/16-inch fillister-head screw (refer to *Figure 7-1. Back Case Screws*).
 13. Attach the back case to the front case using four 2-56 x 3/8-inch flat-head screws and one 10-32 x 3/8-inch flat-head screw at the top left. Tighten all screws.
 14. Carefully seal the outside of the pump using RTV in the seam; do not get RTV in the power switch or battery door areas. Wipe off any excess RTV that goes beyond the indent part of the seam.

7.5

Back Case Assembly

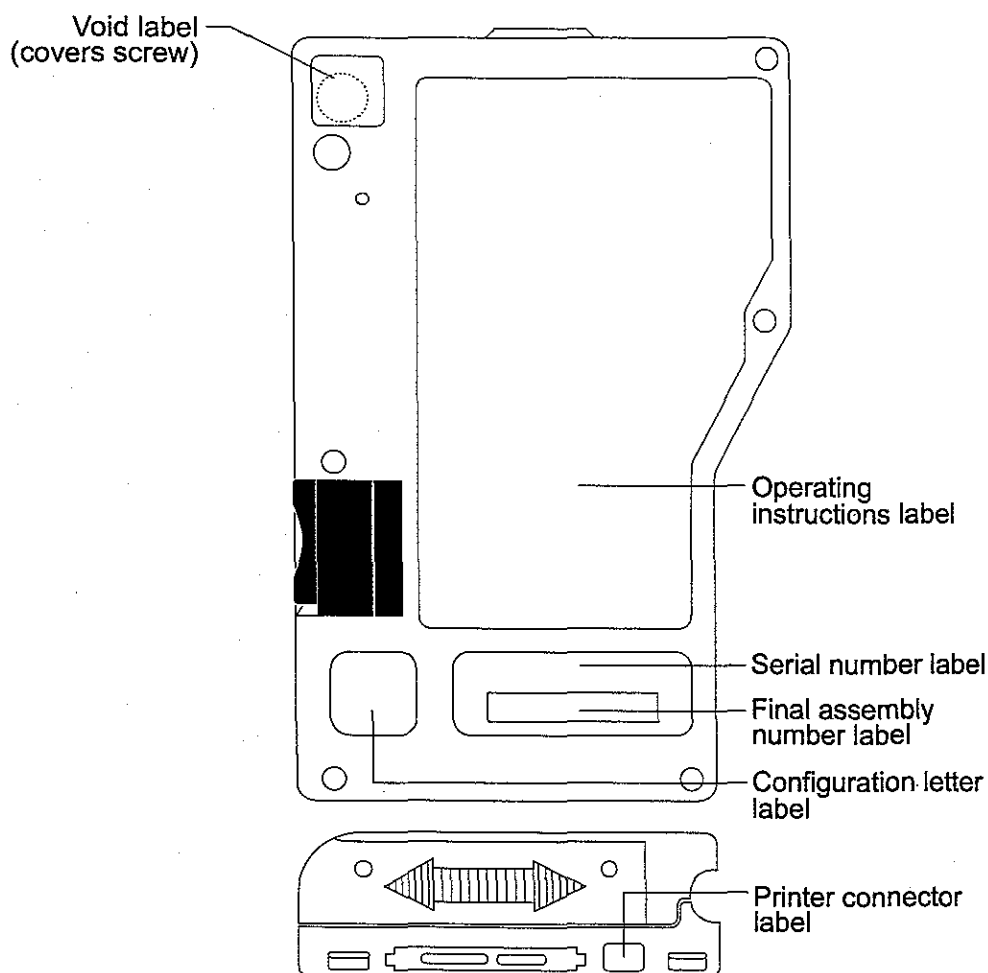
The back case assembly is sold with the kapton insulator installed and the labels in place (refer to *Figure 7-10. Back Case Labels*).

Parts Available:

- ☐ Back Case Assembly (AIM or AIM Plus)
- ☐ AIM Beeper
- ☐ Beeper Adhesive (for AIM only)
- ☐ Printer Connector Label

Note: Infusion pumps are critical devices and are therefore serialized for customer safety per FDA Good Manufacturing Practices and Abbott Guidelines. The serial number is crucial for tracking the manufacture, sale, and maintenance of each device and must not be altered for any reason at any time.

To assure serial number, final assembly number, and service revision letter integrity, these must be placed on the back case assembly per order by Abbott Technical Service.



5C-13_50

Figure 7-10. Back Case Labels

Adhere to the following procedure when replacing a back case assembly:

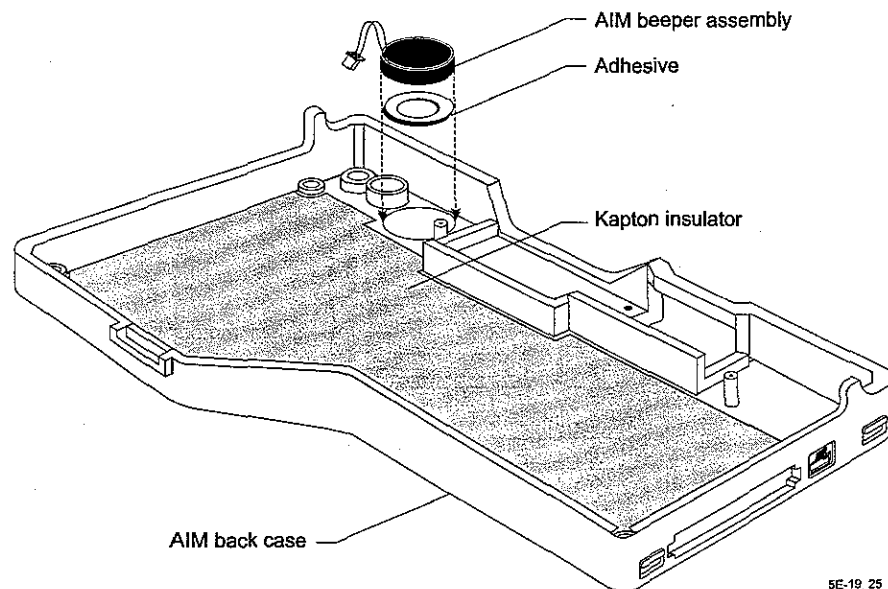
1. Using a **copy** of the Bottom Case Workorder Record provided in the Spare Parts Price List, record the serial number, final assembly number, and service/revision letter of the pump. Specify AIM or AIM Plus. Sign and date the form, then fax or mail the form with the order to Abbott.
2. When receiving a replacement back case assembly, assure that the serial number is matched to the correct pump being serviced. If the serial number does not match, contact Abbott Technical Service.

Complete the reassembly as directed in Section 7.4, Pump Reassembly Procedure, then complete the PVT and burn-in test as described in Section 5, *Maintenance and Service Tests*.

7.5.1

AIM Beeper

1. If replacing the back case but not the beeper (piezo element), remove the beeper from the old back case and clean adhesive from the beeper. If replacing the beeper but not the back case, remove the beeper from the back case and clean adhesive from the case.
2. Remove the paper backing on one side of the beeper adhesive and affix the adhesive in the recess in the back case (refer to Figure 7-11. *AIM Beeper Installation*).
3. Remove the remaining paper backing from the adhesive and press the beeper onto the adhesive with center hold facing down toward the case.



5E-19_25

Figure 7-11. AIM Beeper Installation

7.6

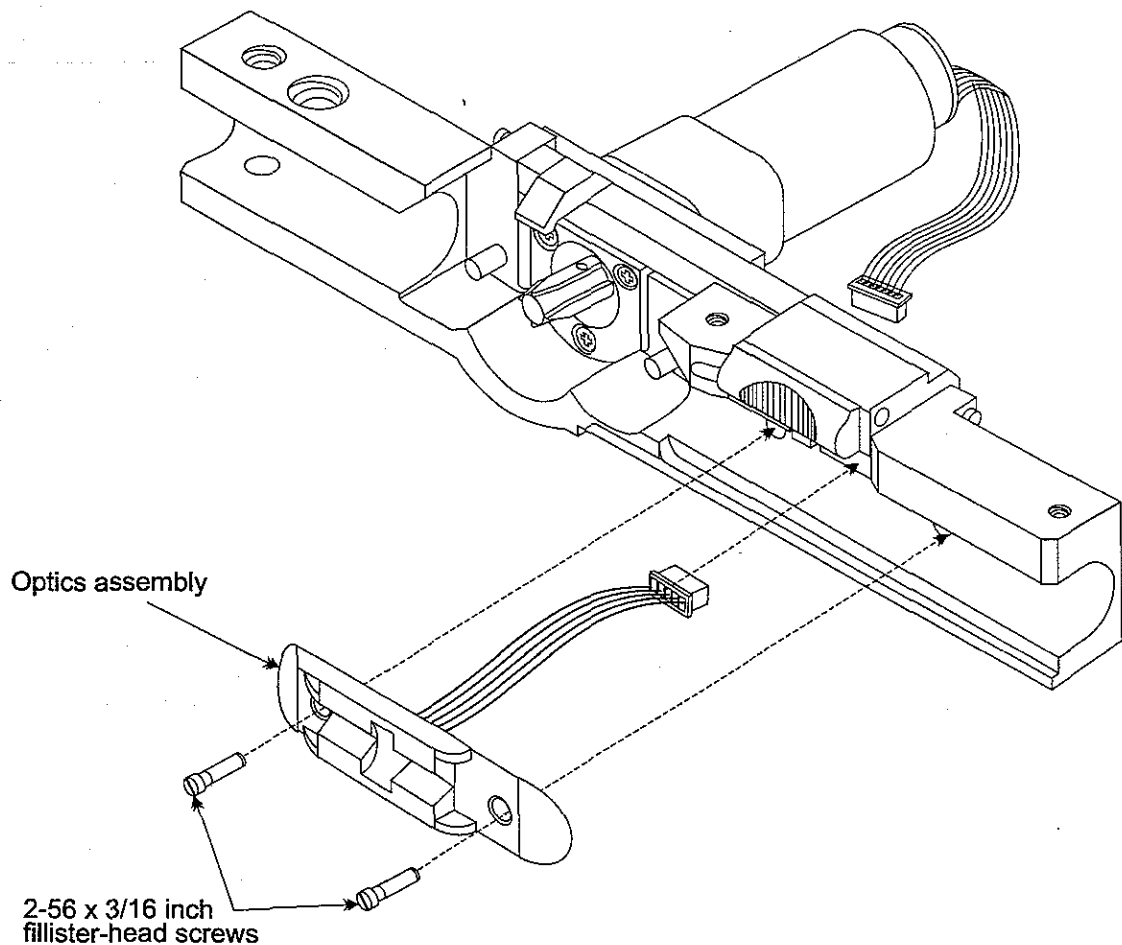
Optics Assembly

The optics assembly comes fully assembled.

Parts Available:

- ❑ Optics Assembly
- ❑ 2-56 x 3/16-inch fillister-head screws (2)

1. Remove the two screws holding the optics assembly to the motor frame and detach the optics assembly from the motor frame.
2. Place the new optics assembly on the motor frame by guiding the connector through the large hole in the motor frame and seating the optics carrier on the frame (refer to *Figure 7-12. Optics Carrier to Motor Frame*).
3. Secure the optics assembly to the motor frame with two 2-56 x 3/16 inch fillister-head screws and tighten.
4. Complete reassembly as directed in Section 7.4, Pump Reassembly Procedure, then complete the PVT and burn-in test as described in Section 5, *Maintenance and Service Tests*.



5D-16_50

Figure 7-12. Optics Carrier to Motor Frame

7.7 Motor Assembly

The motor assembly comes with the motor, connector wires, and housing assembled.

Parts Available:

- ☐ Motor Assembly
- ☐ Shaft Extension
- ☐ 2-56 Set Screw
- ☐ M2 x 15 mm flat-head screws (3)

Equipment/Material Required:

- ☐ Allen Wrench, .035 inch
- ☐ Loctite® Threadlocker 222
- ☐ Loctite 401 Adhesive

1. Remove the screws holding the motor to the motor frame and lift the motor from the frame.
2. Attach the shaft extension to the new motor by applying adhesive to the end of the motor shaft, partially inserting the set screw into the extension, then placing the extension onto the shaft. Assure that the extension is completely seated, then tighten the set screw.
3. Align the motor mounting holes to the holes in the motor frame and assure that the motor wires are turned toward the optics carrier end of the motor frame (refer to *Figure 7-6. Motor Assembly to Motor Frame*). Place the motor assembly through the back of the motor frame.
4. Apply the threadlocker to the M2 x 15 mm screws and thread into place. Tighten the screws.
5. Complete the reassembly as directed in Section 7.4, Pump Reassembly Procedure, then complete the PVT and burn-in test as described in *Section 5, Maintenance and Service Tests*.

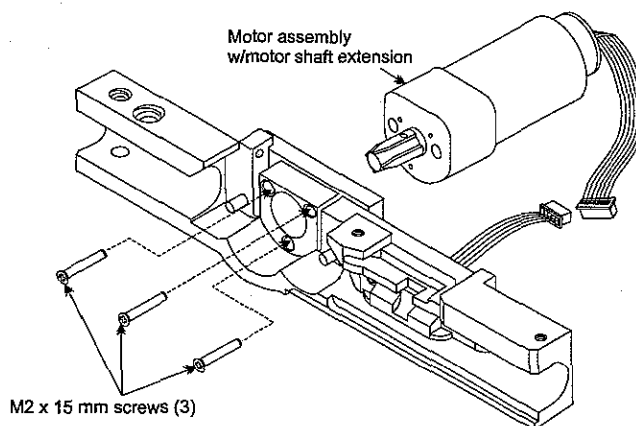


Figure 7-13. Motor Assembly to Motor Frame

7.8 Latch Assembly

The latch assembly comes fully assembled. The spring or pivot pins may be replaced as required.

Parts Available:

- ☐ Latch Assembly
- ☐ Ejector pivot pins (2)
- ☐ Latch spring
- ☐ 6-32 x 1/8-inch socket cup point set screw

1. Clean RTV from the eject pivot pin surface.
2. Remove the ejector pivot pins and lift the latch assembly from the motor frame (refer to).
3. Position the replacement latch assembly into the motor frame and insert the pivot pins.
4. Complete the reassembly as directed in Section 7.4, Pump Reassembly Procedure, then complete the PVT and burn-in test as described in *Section 5, Maintenance and Service Tests*.

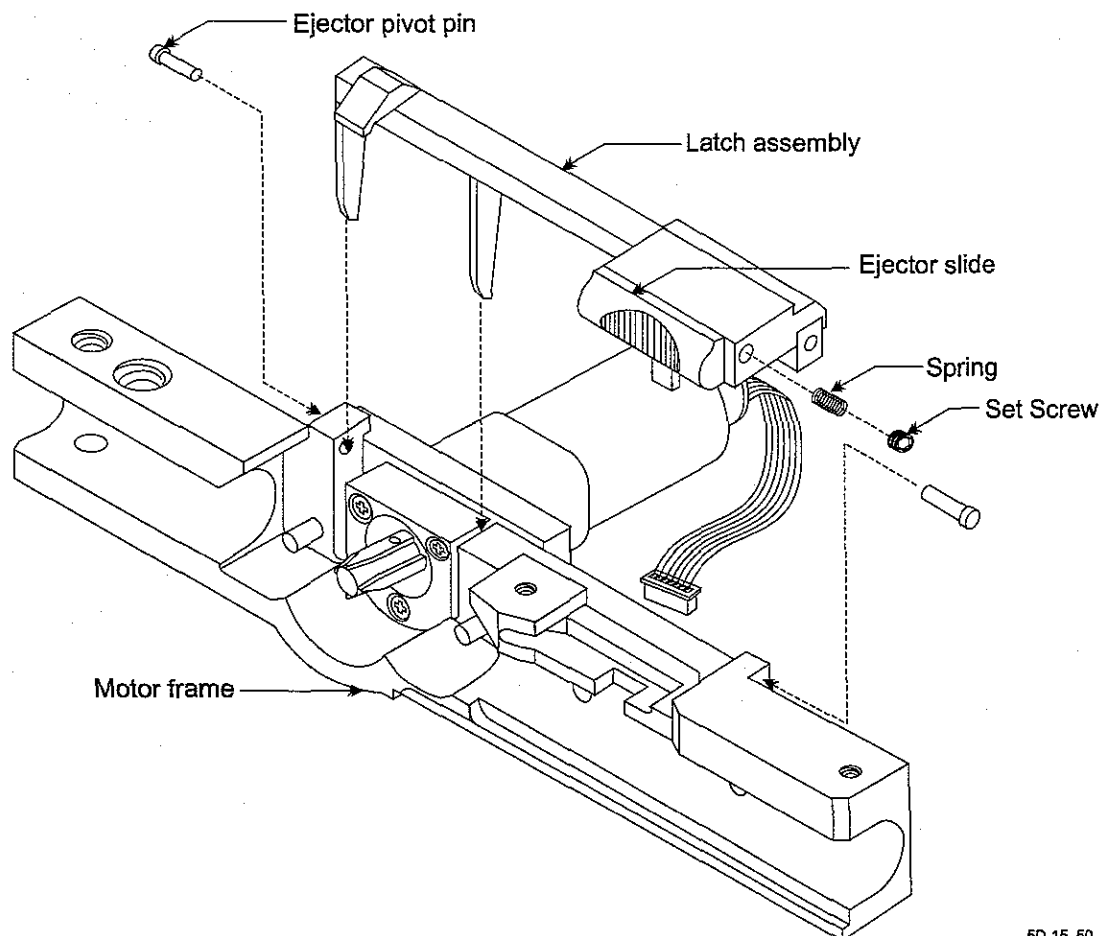


Figure 7-14. Latch Assembly Motor Frame

5D-15_50

7.8.1

Latch Spring

Equipment/Material Required:

- ☐ Allen Wrench
- ☐ Loctite® Threadlocker 222

Note: The pump does not require disassembly to replace the spring. To access the spring, slide the latch down, then out. The PVT is not required if the pump is not disassembled.

To replace the spring only:

1. Use Allen wrench to remove set screw (refer to).
2. Remove the spring to be replaced. Place the new spring in the lever arm cavity.
3. Apply Threadlocker to the threads of the set screw and insert the screw into the cavity; do not get Threadlocker in the spring area. Tighten the screw.
4. Check the ejector slide for free movement.

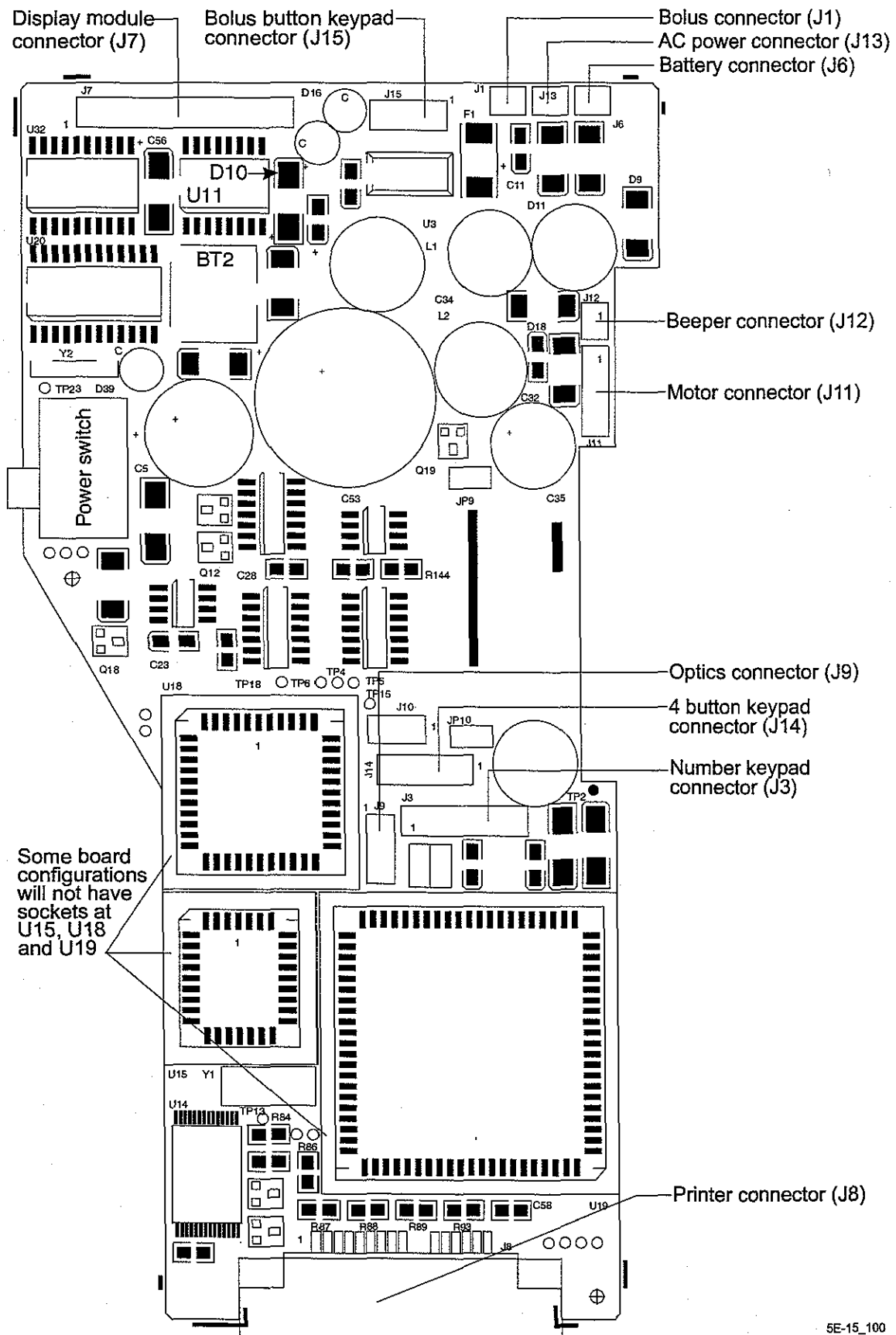


Figure 7-15. PCB Front View

7.9

PCB Assembly

The PCB assemblies come fully assembled and tested. The AIM Plus PCB assembly comes with the beeper installed.

Parts Available:

- ☐ PCB Assembly (AIM or AIM Plus)
- ☐ AIM Plus Beeper Assembly
- ☐ Additional components listed on Spare Parts Price List

CAUTION: The PCB assembly is electrostatic sensitive. Use ESD safety and precautionary methods while working with the PCB.

Refer to *Section 9, Drawings*, for detailed schematics and drawings of the AIM and AIM Plus printed circuit boards.

Replace individual components using standard PCB handling procedures. For the AIM Plus, replace the beeper as described.

After replacing the entire PCB assembly or any individual component, complete reassembly as directed in *Section 7.4, Pump Reassembly Procedure*, then complete the PVT and burn-in test as described in *Section 5, Maintenance and Service Tests*.

7.9.1

AIM Plus Beeper

Materials Required:

- ☐ Loctite 710 accelerator
 - ☐ Loctite 454 adhesive
 - ☐ DP-190 epoxy adhesive
1. Remove the old beeper (audio transducer) from the PCB and clean off excess adhesive from the PCB.
 2. Apply Loctite 710 accelerator to top of U11 on the PCB. Wait approximately 3 seconds, then apply a bead of 454 adhesive to the accelerator.
 3. Press the replacement beeper assembly onto U11. Beeper should be against BT2 and diode D10 on the motor frame side with sound hole pointing away from the motor frame (refer to). Hold for approximately five seconds.
 4. Apply a bead of DP-190 to the area between BT2 and the beeper. Allow adhesive to cure for a minimum of six hours.

7.10

Front Case Assembly

The front case assembly includes labels, display window, spacers and battery connections. Additional assemblies and components are available for replacement as detailed below.

Note: The keypads are NOT reusable. If replacing the front case, also replace all three keypads.

Parts Available:

- ☐ Front Case Assembly
- ☐ Numeric Keypad
- ☐ Function Keypad (AIM or AIM Plus)
- ☐ Bolus Keypad
- ☐ Display Window (AIM or AIM Plus)
- ☐ AC Power Label
- ☐ Bolus Label
- ☐ Power Switch Label
- ☐ Printer Connector Label
- ☐ Bolus Jack Assembly (with cable, connector pin, #10 lockwasher and #10 knurled nut)
- ☐ AC Power Jack Assembly (with cable, connector pin and 5/16-inch knurled nut)
- ☐ Battery Connector Cable Assembly (with clips)
- ☐ Battery Jumper Assembly (with clips)
- ☐ Battery Door (with interconnect PCB installed)

After following the instructions below to replace the indicated component or assembly, complete reassembly as directed in *Section 7.4, Pump Reassembly Procedure*, then complete the PVT and burn-in test as described in *Section 5, Maintenance and Service Tests*.

7.10.1

Keypads

Note: The AIM and AIM Plus function keypads are NOT interchangeable.

1. Detach the keypad to be replaced from the case and remove any residue.
2. Remove the protective paper from the back of the new keypad.
3. Guide the keypad ribbon through the appropriate slot in the front case and place the keypad in the recessed area of the case (refer to).
4. Rub the front of the keypad to ensure that the adhesive firmly attaches to the case.

7.10.2

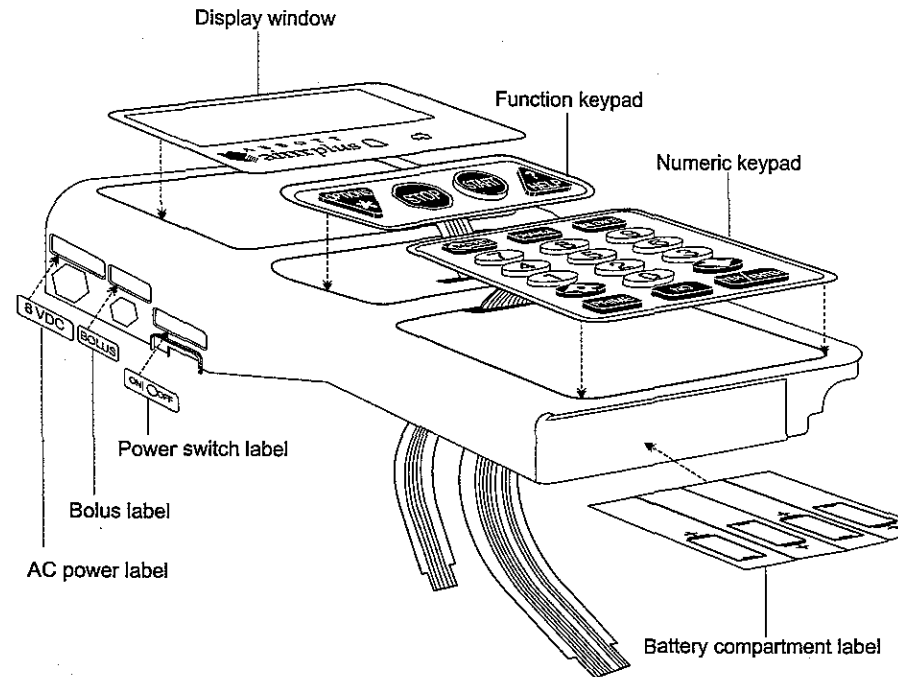
Display Window

1. If replacing the window, detach the window to be replaced from the front case and remove any residue.
2. Remove the protective paper from the back of the new display window.
3. Place the label into the appropriate recessed area on the front face of the pump (refer to). Remove protective covering from the front of the label.

7.10.3

Front Case Labels

1. If replacing a label, detach the label to be replaced from the front case and remove any residue. To replace battery polarity label, use flux remover to eliminate silk screen prior to installing battery label.
2. Remove the protective backing from the new label and attach to the appropriate recessed area on the front case(refer to).



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Figure 7-16. Front Case Keypads and Labels

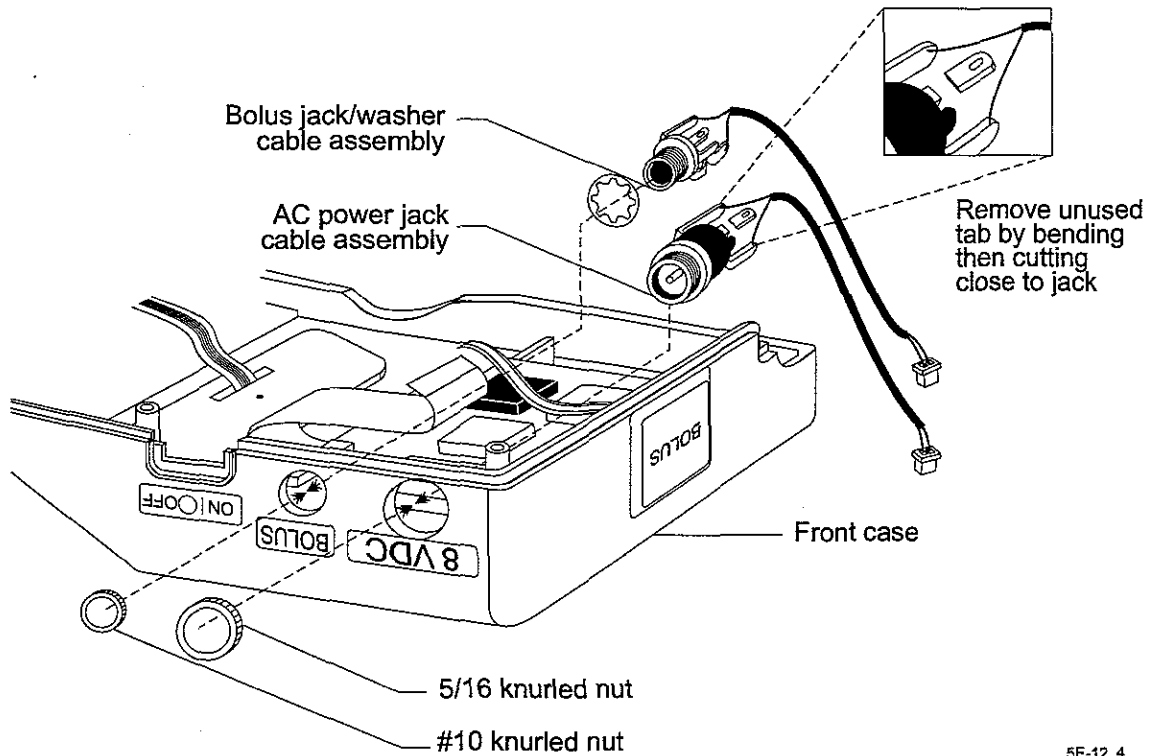


Figure 7-17. Bolus and AC Power Jack Installation

7.10.4

Bolus Jack

Equipment/Material required:

- ☐ Knurled Nut Driver
- ☐ Loctite 425

1. Remove the knurled nut with the driver. Pull the jack to be replaced and lockwasher clear of the case.
2. With the lockwasher between the new jack and the inside of the front case, install the jack into the appropriate hole in the case (refer to).
3. Apply a drop of Loctite 425 to threads of jack. Tighten by turning knurled nut with driver.

7.10.5

AC Power Jack

Equipment/Material required:

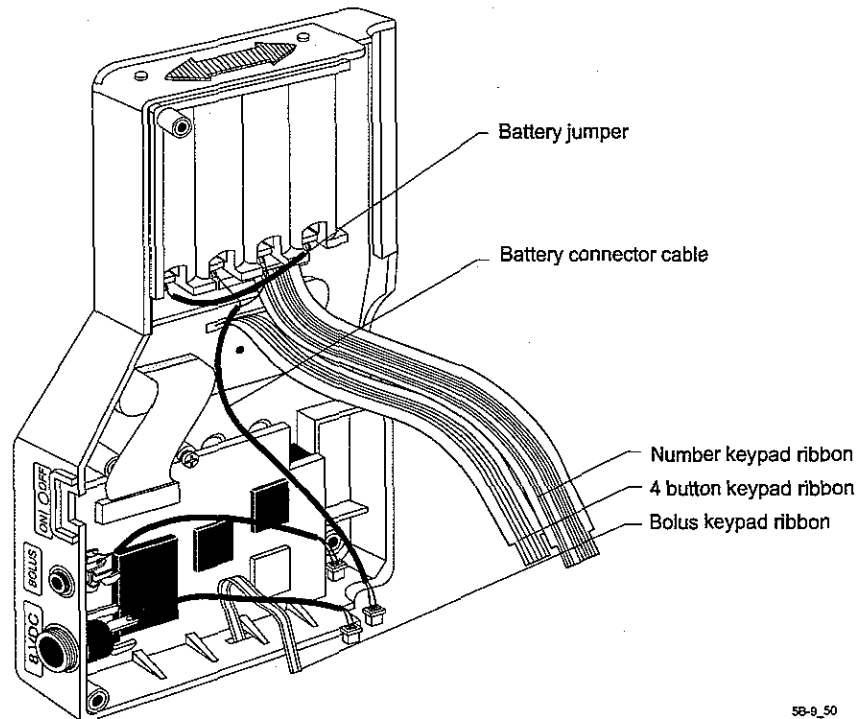
- ☐ Knurled Nut Driver
- ☐ Pliers
- ☐ Wire Cutters
- ☐ Loctite 425

1. Remove the knurled nut with the driver. Pull the jack to be replaced clear of the case.
2. Use the pliers to bend back unattached tab of the new AC power jack (refer to). Use wire cutters to cut tab as close to base of tab as possible. Use pliers to lightly flatten remainder of cut tab. When installing the jack, place the space where the tab was removed facing up to create clearance room for the FFC jumper.
3. Place a drop of Loctite 425 on the inner two threads of the jack. Install the jack into the appropriate hole in the case. Tighten by turning knurled nut with driver while holding the jack in position.

7.10.6

Battery Connector Cable and Jumper

1. Disconnect the component(s) to be replaced.
2. Install a new battery connection cable assembly by pressing the clips into two inside slots in the battery compartment. The red wire should be on the side farthest from the bolus and power jacks (refer to *Figure 7-16. Front Case Keypads and Labels*).
3. Install a new battery connection jumper assembly by pressing the clips into the two outside slots in the battery compartment.



58-9_50

Figure 7-18. Battery Connections

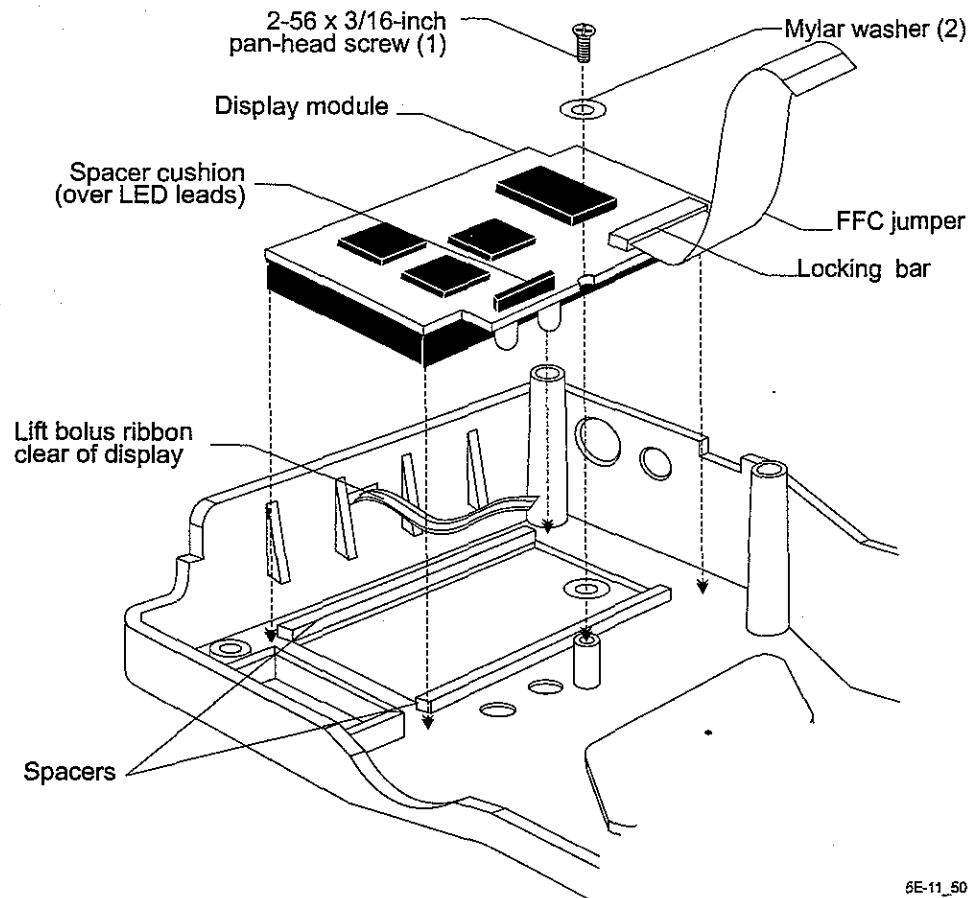
7.11

Display Module

The display module assembly includes the display module and spacer cushion installed on top of LED leads (refer to).

Parts Available:

- ☐ Display Module Assembly
 - ☐ FFC jumper
 - ☐ Spacers (two required)
 - ☐ Spacer Cushion
 - ☐ 2-56 x 3/16-inch pan-head screw
 - ☐ Mylar washer (two required)
1. Assure that spacers are in place inside of the front case. If required, install new spacers by removing the protective backing and affixing each spacer in the recessed area inside the front case.
 2. Place the display module over the window and under the molded overhang in the top case.
 3. Secure the display module to the front case with a 2-56 x 3/16-inch pan-head screw.



6E-11_50

Figure 7-19. Display Module Installation

7.11.1

FFC Jumper

1. Pull the locking bar back to unlock the display connector.
2. Insert the FFC jumper into the connector with the exposed contacts facing away from the display. Gently bend the FFC jumper as shown in .
3. Push the locking bar back to lock the display connector.

7.11.2

Spacer Cushion

If the pump being serviced does not have a spacer cushion installed on the display module, it is recommended to install one as described below.

1. Remove the protective backing from the spacer cushion.
2. Align the edge of the cushion to the left edge of the PCB and apply over the four protruding LED leads on the display module. Press firmly into place to assure adhesion.

Section 8

Specifications

Physical

Dimensions: 15.2 (H) x 10.2 (W) x 3.8 (D) cm (6.0 x 4.0 x 1.5 in)

Weight: Approximately 0.45 kg (1 lb)

Functional

Pump Mechanism: Dual microprocessor-controlled eccentric-rotor peristaltic motor

Display: Four-line, sixteen-character liquid crystal display (LCD) with adjustable display contrast and backlight
On AC power: continuously backlit
On battery power: continuously backlit during programming, program review, and history display. At other times, the backlight is activated by keystrokes and remains on for three seconds after the keystroke. Pressing the remote bolus switch does not activate the backlight.

Time of Day Clock: 12 or 24 hour clock; accuracy: 1 minutes/month or better

Operating Controls: Keypads: 22 raised profile switches with 4 - 15 oz. actuation force; AIM Plus STOP key has flat profile and 6 - 20 oz. actuation force.
ON/OFF: One electromechanical switch
Bolus Activation: Button on the top of the pump and jack for remote switch connection

Printer Interface: Jack and isolated interface circuit
Printers: Kodak Diconix 150 Plus or 180si, Seiko DPU411 or DPU414
Printer Port: RS232C serial interface port

Memory Protection: Nonvolatile memory of up to 512 events for up to one year after power is removed.

Electrical Safety: Meets CSA (NRTL) guidelines.

Environmental

Temperature Ranges: Operating: +10 to +40 degrees Celsius
Shipping and Storage: -20 to +60 degrees Celsius

Relative Humidity: 10 to 90 percent

Atmospheric Pressure: 0 to 3,000 m (0 to 10,000 ft) equivalent pressure

Power Sources

AC Power: Green LED marked with plug icon lights when pump connected to AC power (mains).
Use Abbott List 13586 AC Power Adapter with 3.6 m (12 ft) cord and molded plug.

Power Supply	Input	Output
13586-04	120 VAC 60 Hz 0.06 A	8 VDC 0.4 A

Disposable Batteries: Four AA alkaline batteries
Capacity: At least 3400 mL at rates above 50.0 mL/hr and at least 60 hours at rates of 50.0 mL/hr or below.

Rechargeable Pack: Attachable separate battery pack
Recharge time: Full recharge requires at least 14 hours.
Capacity: At least 3400 mL at rates above 50.0 mL/hr and at least 60 hours at rates of 50.0 mL/hr or below.

Occlusion Pressure

Occlusion Alarm Pressure: 45 psi (310 kPa)

Maximum Delivery Pressure: 45 psi (310 kPa)

Air Sensitivity

HIGH: Pump alarms at approximately 100 μ L of air (when infusing emulsions, pump may require air bubble larger than 100 μ L to cause alarm).

LOW: Pump alarms at approximately 300 μ L of air.

OFF: AIM: Pump alarms at approximately 2 mL of air.
AIM Plus: If user has selected the option for air-eliminating filter in use, there is no alarm; if option for no air-eliminating filter in use selected, pump alarms at approximately 2 mL of air.

Pump Self-Tests & Safety Features

Self-test performed when power switch activated; diagnostic routine, including motor speed and air detection monitoring, repeated continuously while pump powered on; self-test failure generates error detected alarm. Error and alarm conditions are indicated by an audible tone and flashing LED marked with alarm symbol on front of pump; delivery in progress is stopped (if appropriate). Refer to *Section 6.3.2, Alarm Codes*, for a complete list of alert and alarm conditions and troubleshooting information.

Programmable Ranges

Refer to the *Specifications* section in either the *AIM System Operating Manual* or the *AIM Plus System Operating Manual* for program specifications for each delivery mode.

Section 9

Drawings

The following schematics and drawings issued with this manual represent the latest configurations of the AIM and AIM Plus PCBs.

Note: The reverse sides of the following 11" x 17" figures are blank.

Figure 9-1. AIM Analog Schematic

Figure 9-2. AIM Microprocessor (CPU) Schematic

Figure 9-3. AIM Power and Miscellaneous Circuitry Schematic

Figure 9-4. AIM PC Board, Front Side

Figure 9-5. AIM PC Board, Back Side

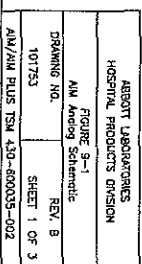
Figure 9-6. AIM Plus Analog Schematic

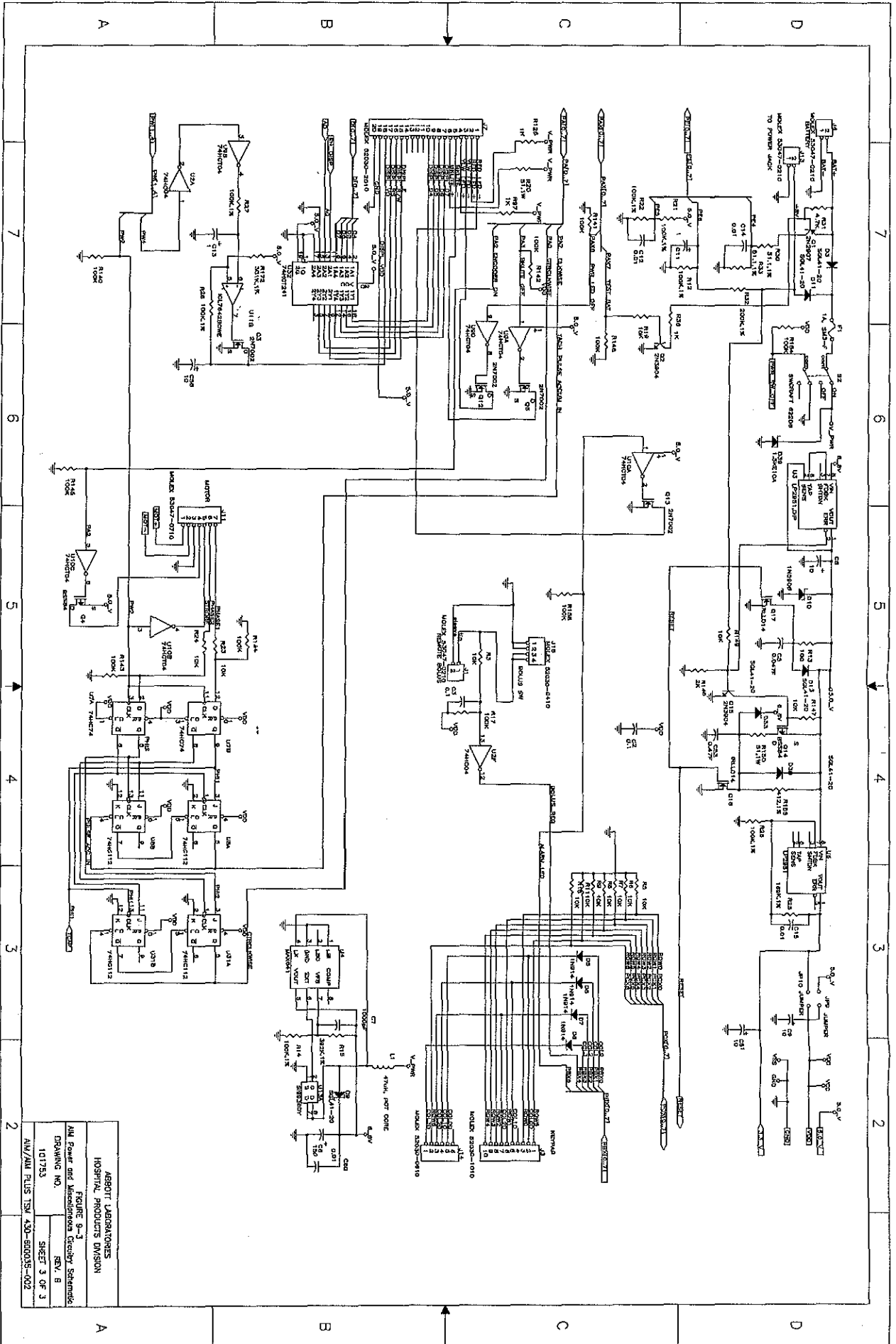
Figure 9-7. AIM Plus Microprocessor (CPU) Schematic

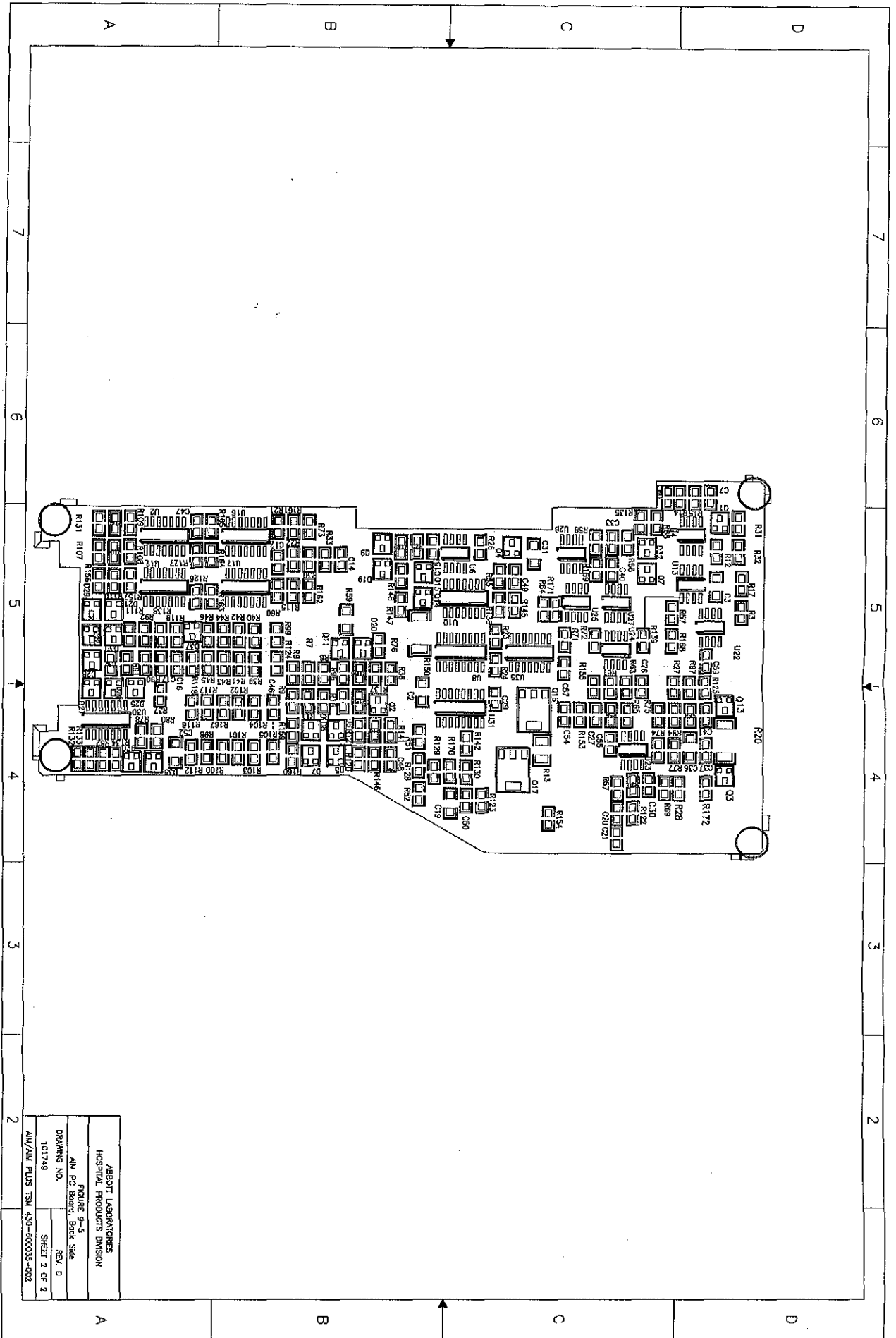
Figure 9-8. AIM Plus Power and Miscellaneous Circuitry Schematic

Figure 9-9. AIM Plus PC Board, Front Side

Figure 9-10. AIM Plus PC Board, Back Side







ARBON LABORATORIES HOSPITAL PRODUCTS DIVISION	
FIGURE 9-5 AIV PC Board, Back Side	
DRAWING NO. 101749	REV. D SHEET 2 OF 2
AIV/AN PLUS TSM 430-600035-002	

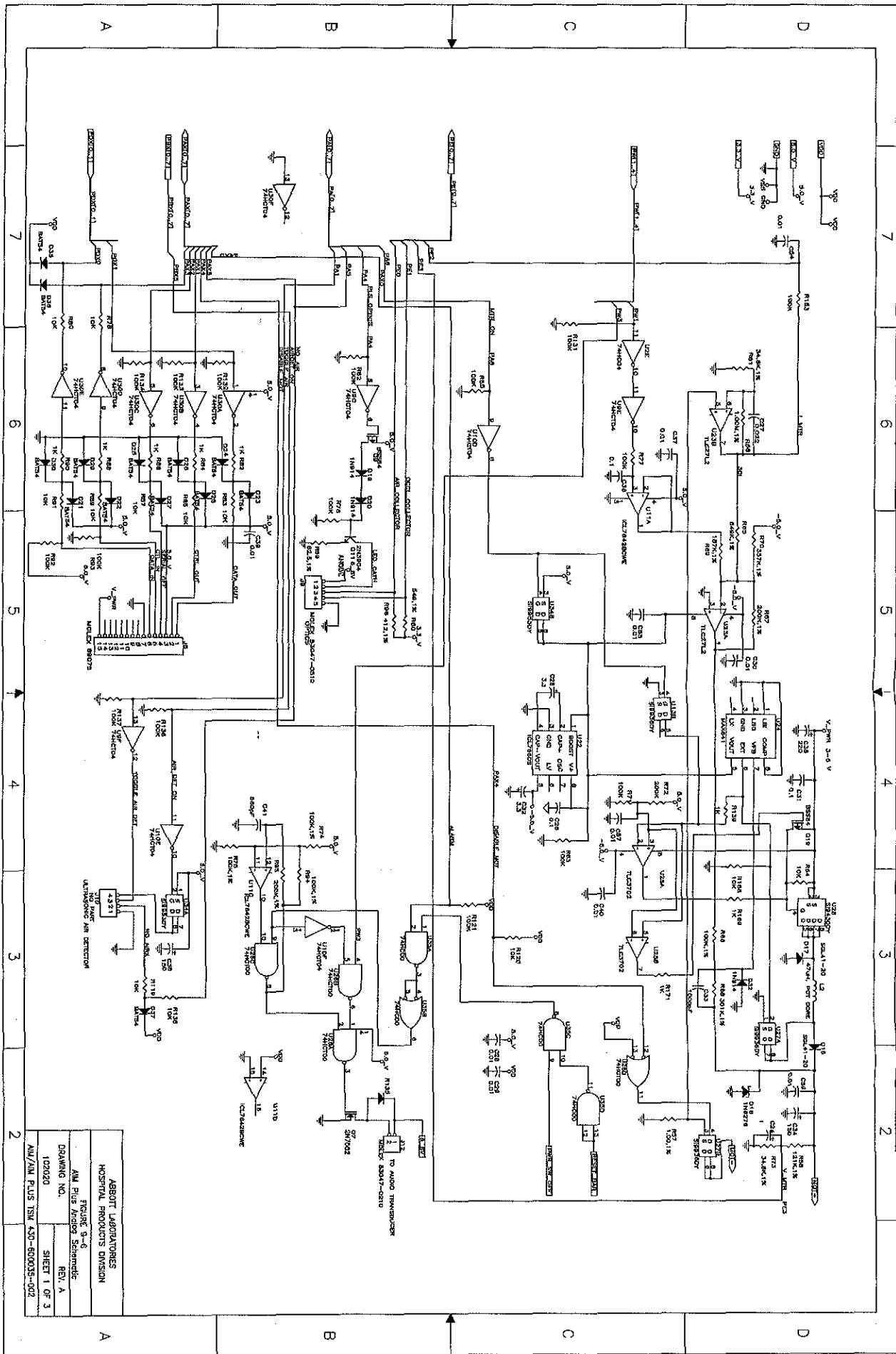
NOTE: SOME BOARD CONFIGURATIONS WILL NOT HAVE SOCKETS AT U15, U18 AND U19.

ABBOTT LABORATORIES
HOSPITAL PRODUCTS DIVISION
FIGURE 9-9
AUX Plus PC Board, Front Side
DRAWING NO. 10200/9
REV. A
SHEET 1 OF 2
JAM/JAM PLUS TSW 430-60035-002

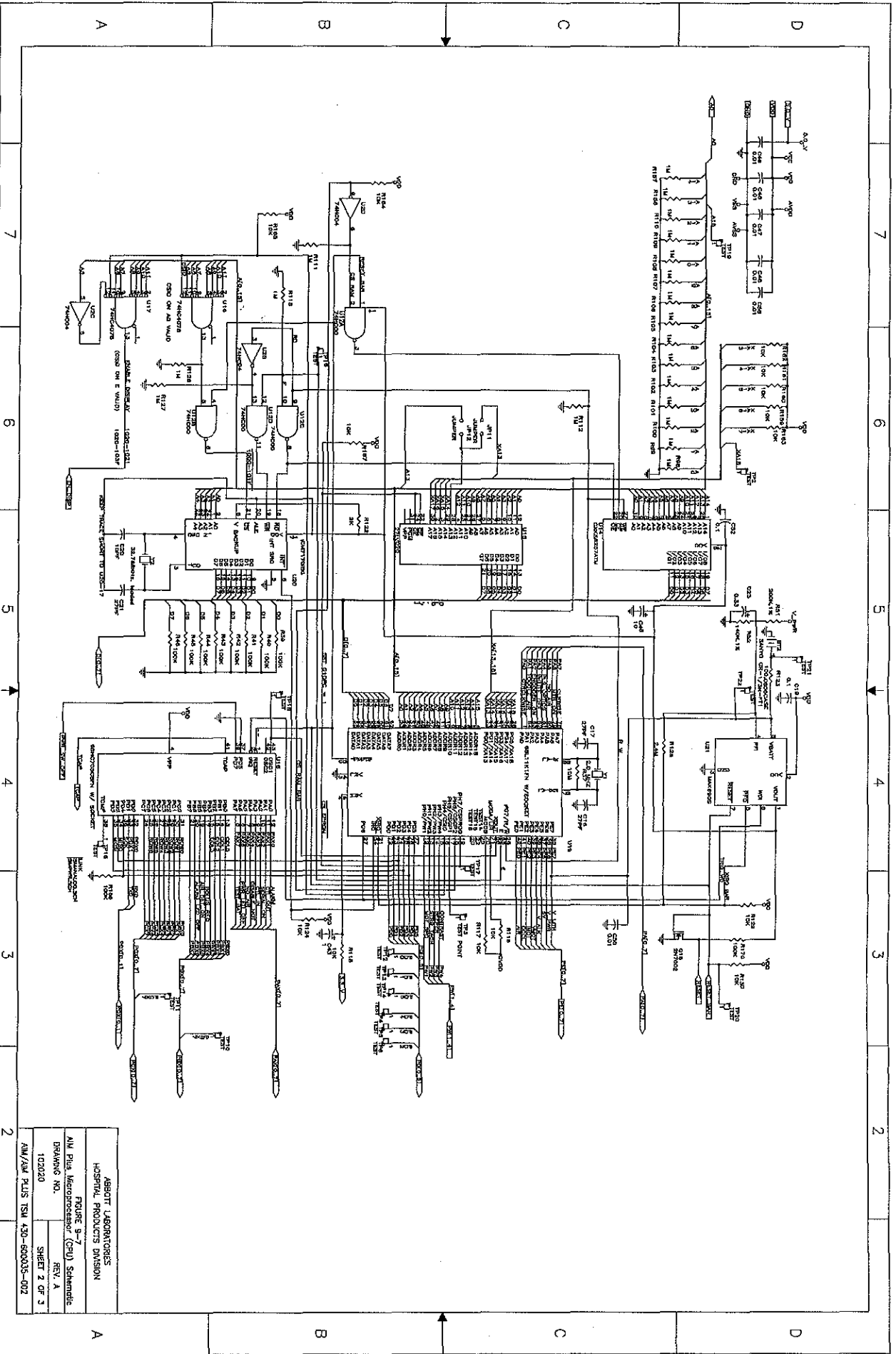
NOTE: SOME BOARD CONFIGURATIONS WILL NOT HAVE SOCKETS AT U15, U18 AND U19.

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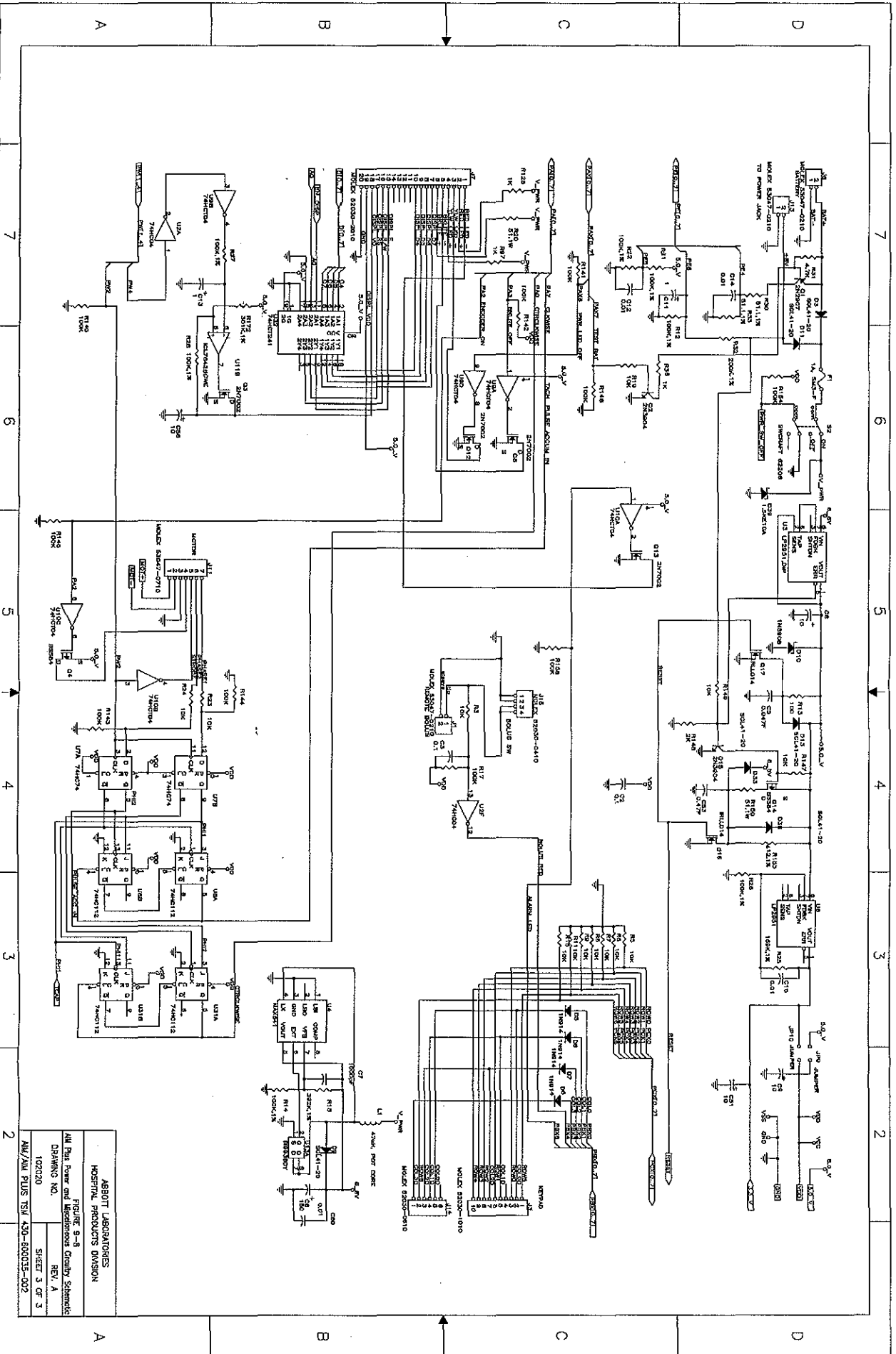
ABBOTT LABORATORIES HOSPITAL PRODUCTS DIVISION FIGURE 9-9 AUX Plus PC Board, Front Side DRAWING NO. 1020/9 SHEET 1 OF 2 JAM/JAM PLUS TSW 430-60035-002
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ABBOTT LABORATORIES
 HOSPITAL PRODUCTS DIVISION
 PROJECT 8-6
 AIM Plus Acids Schematic
 REV. A
 SHEET 1 OF 3
 AIM/AM PLUS TSK 430-500035-002



ABOUT LABORATORIES
 HOSPITAL PRODUCTS DIVISION
 FIGURE 9-7
 P100-Micro (CPU) Schematic
 DRAWING NO. REV. A
 100200 SHEET 2 OF 3
 A10/A11 PLUS TSM 430-66005-002



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CAUTION: Federal (U.S.A.) law restricts this device to sale by or on the order of a physician or other licensed practitioner.

WARNING:

Possible explosion hazard if serviced or repaired in the presence of flammable anesthetics.

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